Materials and Workshop Practice

Instructional-cum-Practical Manual
for
Repair, Maintenance and Rewinding of Electrical Motors

Class XI

MATERIALS AND WORKSHOP PRACTICE

Instructional-cum-Practical Manual
for
Repair, Maintenance and Rewinding of Electrical Motors

Class XI

SACHCHIDANANDA RAY
Project Coordinator

राष्ट्रीय शैक्षिक अनुसंधान और प्रशिक्षण परिषद्
NATIONAL COUNCIL OF EDUCATIONAL RESEARCH AND TRAINING

September 1994
Asvina 1916

P D IT - MGB

Publication Team

C N Rao *Head,* Publication Department

Prabhakar Dwivedi *Chief Editor*
S K Malhotra *Editor*
M G Bhagat *Assistant Editor*

U Prabhakar Rao *Chief Production Officer*
Shiv Kumar *Production Officer*
Arun Chitkara *Assistant Production Officer*
Subodh Srivastava *Production Assistant*

OFFICES OF THE PUBLICATION DEPARTMENT, NCERT

NCERT Campus	C V C Campus	Navjivan Trust Building	CWC Campus
Sri Aurobindo Marg	Chitlapakkam, Chromepet	P O Navjivan	32, B T Road, Sukchar
NEW DELHI 110016	MADRAS 600064	AHMEDABAD 380014	24 PARGANAS 743179

Rs. 35.50

Published at the Publication Department by the Secretary, National Council of Educational Research and Training, Sri Aurobindo Marg, New Delhi 110 016, lasertypeset at Computer Data System, 270, Ground Floor, Satya Niketan, Ring Road, New Delhi 110021 and printed at J K Offset Printers, 315, Jama Masjid, Delhi 110 006

Foreword

The programme of vocationalization of higher secondary education has been accepted by the country as it holds forth great promise for linking education with the productivity and economic development of the country.

In view of the importance of the programme the National Council of Educational Research and Training (NCERT) is making an all-out effort to provide academic support to the implementing agencies in the States One of the major contributions of the NCERT is in the field of curriculum development and in the development of model instructional materials. The materials are developed through workshops in which experts, subject specialists, employees' representatives, curriculum framers and teachers of the vocational courses are involved

The present manual 'Materials and Workshop Practice' has been developed in the manner described above and is meant for the students studying Repair, Maintenance and Rewinding of Electrical Motors (Class XI) and allied vocations It is being published for wider dissemination amongst students and teachers throughout the country I hope that they will find the manual useful

I am grateful to all those who have contributed to the development of this manual I must acknowledge the role played by Prof A K Mishra, Project Director, Pandit Sunderlal Sharma Central Institute of Vocational Education in inspiring his colleagues in their endeavour to develop instructional material Shri S Ray, Senior Lecturer, who functioned as the Project Coordinator deserves special mention for his efforts to bring out this publication

We would welcome suggestions for the improvement of this manual

A K Sharma
Director
National Council of Educational
Research and Training

GANDHIJI'S TALISMAN

"I will give you a talisman. Whenever you are in doubt or when the self becomes too much with you, apply the following test :

Recall the face of the poorest and the weakest man whom you may have seen and ask yourself if the step you contemplate is going to be of any use to him. Will he gain anything by it ? Will it restore him to a control over his own life and destiny ? In other words, will it lead to Swaraj for the hungry and spiritually starving millions ?

Then you will find your doubts and your self melting away."

M K Gandhi

Preface

Ever since the introduction of vocationalization in our school system by several States and Union Territories the paucity of appropriate instructional materials has been felt as one of the major constraints in implementation of the programmes and also a source of great hardship to pupils offering vocational studies at the higher secondary stage

The erstwhile Department of Vocationalization of Education of the NCERT, New Delhi started a modest programme of developing instructional materials of diverse types to fill up this void in all major areas of vocational education The task is too gigantic to be completed by any single agency but the model materials developed by the DVE might provide guidance and impetus to the authors and agencies desiring to contribute in this area These are based on the national guidelines developed by a Working Group of Experts constituted by the NCERT.

The present manual is on 'Materials and Workshop Practice' and is meant for the pupils and teachers teaching Repair, Maintenance and Rewinding of Electrical Motors (Class XI) and allied vocations being offered in a number of States It contains activities (Practical Exercises) to be performed by pupils with simple steps to follow, precautions to be taken and data to be recorded and processed. Each activity is complete with objective, relevant information, procedure, evaluation, etc It is hoped that the users will find them immensely useful

The experimental edition of the manual was developed by a group of experts in a workshop held at the Institute of Engineering and Rural Technology, Allahabad

The names of the contributors and reviewer are mentioned elsewhere and their contributions are admirably acknowledged Shri S Ray, Coordinator of this project, deserves special thanks for editing, reviewing and bringing out the manual in the present form The assistance of the Institute of Engineering and Rural Technology, Allahabad and the erstwhile Department of Vocationalization of Education, NCERT is also thankfully acknowledged

Arun K. Mishra
Project Director
Pandit Sunderlal Sharma
Central Institute of Vocational Education

Acknowledgements

The following experts participated in the workshop conducted by the NCERT Their contribution is gratefully acknowledged

Contributors

Prof A Chakrabarti
Shri Asit Das Gupta
Shri T D Bhist
Shri K G Vastrad
Shri Amar Singh
Shri Sachchidananda Ray

Reviewer

Shri Sachchidananda Ray

About the Manual

Under the programme of Vocationalization of Education about fifty different vocational courses in the area of engineering and technology have been introduced by seventeen States and four Union Territories so far for the last thirteen or fourteen years From the beginning, the erstwhile Department of Vocationalization of Education in the NCERT has been working hand in hand with the State organisations concerned, through various programmes organised for State officials, vocational teachers and others In fact, by now the Department has conducted on-the-spot studies of vocational programmes in large number of States to find out merits and demerits of the programmes and to suggest appropriate measures to resolve the problems in "engineering and technical vocational education" These programmes have revealed that there was a great dearth of suitable instructional materials, the need for practical manuals, especially, was urgently felt. The development of instructional materials and the imparting of practical training become even more important when one considers the purpose for which the vocationalization of education was launched The main aim of the programmes was to prepare the pupil for purposeful and gainful employment (wage-employment or self-employment)

The Department constituted a Working Group in 1982 to formulate guidelines for models for a variety of instructional materials based on the guidelines formulated by the Working Group. "Repair, Maintenance and Rewinding of Electrical Motors" was selected by the Department for the purpose of development of instructional materials in a phased manner To begin with, the development of instructional-cum-practical manuals has been taken up

The content of ''Repair, Maintenance and Rewinding of Electrical Motors'' course was thoroughly analysed and it was felt that six manuals would be necessary to cater to the needs of the course The present manual 'Materials and Workshop Practice' is one of them This manual is intended to help both the teachers and pupils Each activity is complete with a specific objective, related information, equipment and materials, procedure, observation, precaution and questions for evaluation In order to acquaint the pupils with each activity, the teacher should provide them required theoretical knowledge or information related to the activity. This will help the pupils for proper understanding of the activity and enable them to perform the activity properly and effectively

In order to meet the stipulated objectives, the activities include the study and operation of tools and instruments which an electric motor repairer would be required to use in his professional career

The evaluation of the activities performed by the pupils shall be based on the specific objectives The teacher shall evaluate all the aspects which are relevant to achieve the specific objectives This will contribute towards the "expected behavioural outcome" Evaluation is an important aspect of performing the activities Each activity should be assessed through evaluation based on knowledge, acquired skills and competencies, attitude and aptitude towards work, activity performance, application, maintenance of activity record.

Tabular representation of suggested evaluation scheme is as follows

Sl No.	*Components*	*Marks alloted*	*Marks awarded*
(i)	Knowledge	20	
(ii)	Acquired skills and competencies	35	
(iii)	Attitude and aptitude towards work	15	
(iv)	Activity performance	10	
(v)	Application	10	
(vi)	Maintenance of activity record	1	
	Total Marks	100	

At the end of each activity, some questions for evaluation are given The pupils shall answer these questions on completion of each activity and the teacher shall examine them If required, necessary corrections and suitable suggestions should be incorporated by the teacher However, the answer to these questions should not be considered for the purpose of awarding final work or grade

Contents

ACTIVITY 1

To Study the Layout of an Electrical Machine Repair Shop

Specific Objectives

(i) To enlist and identify the equipment machine and work benches in a repair shop
(ii) To acquire knowledge about the use and working of each equipment and machine in a repair shop
(iii) To move safely in the workshop
(iv) To operate all light points, and use 3 pin plug points for connecting portable electrical devices from different boards situated in the workshop
(v) To act quickly during emergency like fire etc.
(vi) To move out of the workshop through the exit door along with equipment that need to be saved

Related Information

A motor repairing workshop is the place where damaged/faulty motors are brought for repair/maintenance

Adequate provision must exist in the workshop to unload the motors brought for repair and move them safely to the location, where repair is to be carried out Sufficient space and arrangements should be available in the workshop to carry out various activities for repair and maintenance of motors, i e inspection, dismantling, replacement, repair of damaged parts, rewinding, making proper insulation, drying and baking, painting and finally testing before despatching the motor to site. For the above activity, different work benches are installed in the workshop For carrying out cutting, shaping, machining, drilling, grinding, winding, baking, welding the following electrically operated machines are installed in the workshop, (i) Wood cutting power saw, (ii) metal cutting power saw, (iii) vertical drilling machine, (iv) multipurpose small lathe machine, (v) grinder, (vi) welding set, (vii) baking machine, and (viii) overhead crane/lifting jigs etc

Adequate illumination arrangement is made by combination of fixtures, lamps and tube lights etc, so that sufficient light is available at every work bench As a result workers do not feel inconvenience or visual fatigue during their work Power supply boards are so installed that the machines can be operated at ease Portable fire fighting devices like CO_2 type/dry chemical powder type are installed at suitable location in the work shop so that these can be easily used in emergency Adequate ventilation is provided in motor repairing workshop to remove contaminated air and circulation of fresh air Fans and exhaust fans are fitted for this purpose A wooden display board is generally fitted near the entrance which can be easily seen by any body entering the workshop Telephone number of nearest fire fighting station/hospital/dispensary is prominently displayed in this board and other related information A shock treatment chart and safety posters are also displayed at suitable locations in the workshop In Fig 1 1 a typical layout of motor repair workshop has been shown

Materials

(i) Paper
(ii) Pencil

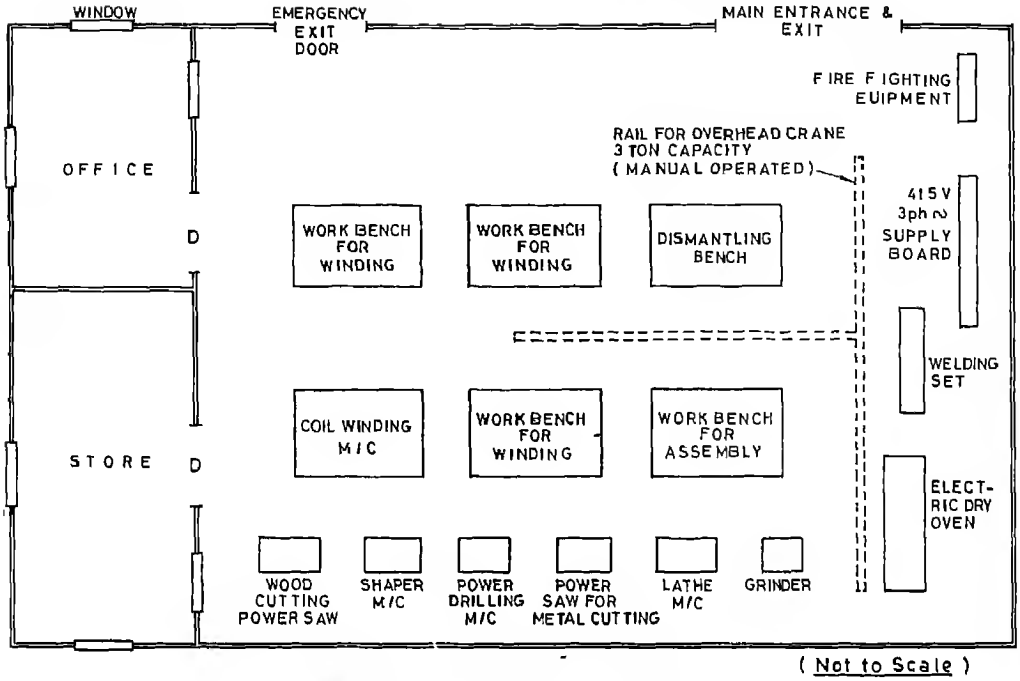


Fig. 1.1 Layout of a motor repair workshop

(iii) Scale
(iv) Eraser

Procedure

(i) Observe the main entrance/emergency exist, their opening and closing mechanism (collapsible steel shutter/rolling shutter etc)
(ii) Locate the position of power supply board, incoming supply line switch and observe the arrangement of switches on the board
(iii) Locate the position of portable fire fighting equipment and observe their type
(iv) Go round the workshop through the passage way between various work benches and machine rows.
(v) List out the names of machines and work benches in the workshop
(vi) Make a sketch of workshop layout showing location of different machines and work benches

Tabular Record

Sl No.	*Name of Machine/Equipment*	*Quantity*	*Use*	*Drive*

(vii) Identify the switches of each light, fan and exhaust fan in the workshop

(viii) Identify 3 pin plug points for giving connection to portable electrical tools like electric blower/electric hand drilling machine Practice connecting any of the portable electric tools from the plugs

(ix) Understand the purpose and working of each of the machines/equipments and work benches in the workshop

Precautions

(i) Be cautions and watchful while moving in a repair shop

(ii) Keep off from running machines Do not touch any part of a running machine

(iii) Do not operate any machine unless you know its operation

(iv) Do not gossip in a workshop

Questions

(i) How many work benches are required in a repair workshop ?

(ii) Write the name of the machines installed in the workshop for metal cutting/drilling/ machining

(iii) What supply voltages are used for operation of light, fan and different machines in a workshop?

ACTIVITY 2

Study of Shock Treatment Chart

Specific Objectives

(i) To get familiarized with different method of shock treatment (artificial respiration)
(ii) To acquire skill for using the shock treatment chart as and when needed

Related Information

Shock treatment chart is a standard safety reference material which is prominently displayed in workshops and factories The purpose of the chart is to make the worker conscious about electric shock treatment

Initial action to rescue the victim from live electric part is given below

Special Immediate Guidance in Case of Electric Shock

(i) Switch off current – pull out plug and remove victim from danger
(ii) Not to touch victim in contact or live conductor
(iii) Do not use bare hands without protection.
(iv) Stand on dry non-conducting material, rubber mat (If possible)
(v) With care use length of dry cloth, stick, stand on a dry board or on a thick news paper or a bundle of sacking – metallic rope-rubber–electrician's rubber gloves (if possible)
(vi) Never give an unconscious man anything to drink–it may choke him to fetch
(A) Blankets to round patient
(B) Covered hot-water bottles
(C) Bandages and dressings for burns
(D) Warm sweet drinks (These must not be given until patient is conscious and able to swallow)

Follow the above noted methods even if the victim appears dead

Different methods of artificial respiration and steps of artificial respiration procedures are depicted in words and pictures in shock treatment chart Unskilled/semiliterate workers can easily follow the procedures of the each method of artificial respiration The Safety Department/ Medical Officer or incharge of a Workshop should arrange periodical physical demonstration of the method shown in a shock chart to a group of workers Workers may practise different methods of artificial respiration under the guidance of doctor for acquiring skill to give artificial respiration

Equipment and Materials

(i) Electric shock treatment chart.
(ii) Pointer
(iii) A cotton mat

Procedure

(i) Strung the shock treatment chart on a wall.
(ii) Study the shock treatment chart under guidance of your instructor and note down the initial action to be taken for dis-engaging the victim from Live Line
(iii) Spread the cotton mat on the floor (open space) and ask any of your fellow students to volunteer as a victim.

(iv) Let the volunteer victim lay on the mat in the postures as shown in the chart for any method
(v) Practise the particular method of artificial respiration on the victim
(vi) Change the volunteer and practise for other methods one by one
(vii) All students will participate in the practice one by one for each method

Electric Shock Chart

Instructions for Restoration of Persons Suffering from Electric Shock

Instructions in English, Hindi and the local language of the district, for the restoration of persons suffering from electric shock, shall be affixed by the owner in a conspicuous place in every generating station, enclosed sub-station, enclosed switch station and in every factory as defined in clause (m) of section 2 of the Factories Act, 1948 (LXIII of 1948) in which electricity is used and in such other premises where electricity is used as the Inspector may, by notice in writing served on the owner, directs the owner of every generation station, enclosed sub-station, enclosed switch-station, and every factory or other premises to which this rule applies shall ensure that all authorized persons employed by him are acquainted with and are competent to apply the instructions referred to in sub rule (1)

Removal from Contact

If the person is still in contact with the apparatus that has given him the shock, the rescuer should, (if possible) stand on a dry wooden chair while removing the victim Otherwise pull him free using a dry coat, dry rope, coconut matting or stick, preferably standing on a rubber mat or another dry mat handy

Preliminary Steps

Extinguish any sparks if the patient's clothes are smouldering, ascertain if he is breathing and send for a doctor If apparently not breathing, proceed as follows

Fig. 2.1 Expiration pressure applies

To Recover Patient

If there are any burns, avoid, if possible, so placing the patient as to bring pressure on them It is far preferable to operate as in the Figs 2 1 and 2 2, with the face downward If badly burnt front

Whom to contact in case of emergencies

Name	*Address*	*Telephone*
(i) Nearest Doctor		
(ii) Ambulance		
(iii) Hospital		
(iv) Police		
(v) Electricity Complaint		
(vi) Fire Brigade		

to the second method shown latter

Fig 2 2 Inspiration pressure relax

A. Best Method

First Direction

Observe Fig.2 1, "Expiration," Kneel over the patient, rest the hand flat in the small of his back, let your thumbs nearly touch, spread your fingers on each side over his lower ribs as in the first diagram

Now lean firmly but gently forward over patient, exerting, a steady pressure downwards, still following the first diagram

Second Direction

Observe Fig. 2 2, "Inspiration", Rock yourself gently backwards, but do not remove your hands Merely keep them in position for the next expiration pressure Continue these two movements

The double movement should be gone through about fifteen times per minute The object is to keep expanding and contracting the patient's lungs so as to imitate breathing If the operator himself breathes slowly letting the air out as he presses forward, and drawing it in as he rocks backward, he will naturally arrive at the proper rate, and will understand the reason of the movements

Do not cease operations until natural breathing is reestablished It may take half an hour, or even longer, to produce any effect

B. Alternative Method

Should it be expedient to place the patient on his back, first loosen the clothes around the chest and stomach Then place a rolled-up coat, or other improvised pillow beneath the shoulders so that the head falls backwards The tongue should then be drawn forward

Fig. 2 3 Inspiration chest expanded

First Motion

The operator must keel in the position shown by Fig 2 3, grasp the patient just below the elbows, and draw his arms over his head until horizontal, retaining them there for about two seconds

Second Motion

Next bring the patient's arms down on each side of his chest and pressing inwards upon it leaning upon his arms so as to compress his chest as in Fig 2.4

Remain thus for two seconds, and then keep

repeating the two motions at the same rate
NOTE The lung-inflating effect in Fig 2 3, is much assisted if the arms be swung outwards as they are lifted

If more than one person be present, the patient's tongue should also be drawn out during each outward or lung-inflating stroke (Fig 2 3) and released during each inward or long deflating stroke (Fig 2 4).

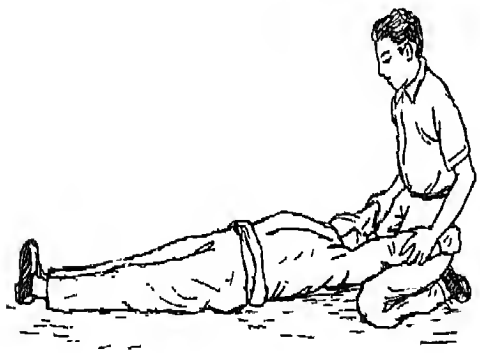


Fig 2 4 Expiration chest compressed

General

Be careful to avoid violent operation, as injury of the internal organs may result from excessive and sudden pressure.

Upon Recovery

Burns, if serious, should be treated with a proper oil dressing Avoid exposing patient to cold Administer no restoratives until the doctor comes Cold water may be given to drink and smelling salts applied in moderation

Precautions

(i) Practise only one method of artificial respiration on a volunteer
(ii) During practice do not hurry but slowly make the movement so that the volunteer may not get hurt
(iii) While standing around to observe the practice do not jostle or frolic or make noise as this may distract the practioner
(iv) See that sufficient light and air reaches the victim and the practitioner when you stand around them

Questions

(i) Name different methods of artificial respiration
(ii) Which method is most simple in your opinion? Justify with reasons
(iii) What precaution will you take during practicing of artificial respiration?
(iv) What action will you take to disengage a person who has gripped a live conductor?

To Practise the Technique for Removing Persons in Contact with Live Wire, Artificial Respiration and Shock Treatment

Specific Objectives

(i) To develop skill for removing a person from the contact of a live wire.

(ii) To give artificial respiration and shock treatments

Related Information

A person gets electric shock if he comes in contact with a live part of electrical equipment and is in touch with earthed surface The severity of the shock depends on the duration and amount of current passing through the body of the person If a current of about 10-15mA magnitude flows through the body for prolonged duration the person will feel acute discomfort His body muscles will get tightened and he will find it difficult to release the live part he has gripped In such circumstance it is of utmost importance to disengage the person from the live part gripped by him The body of the person who will attempt to disengage the victim of electric shock is also conducting As such he may also get severe shock if he does not stand on a non conducting surface like rubber sheet/dry wooden plank or use a non-conducting rod to disengage the victim This point should always be kept in mind while rescuing a person who has come in contact with a live part If the quantum of current flowing through the body of victim is above 25mA his lungs muscle will also get tightened and respiration stopped In such eventuality the victim of the shock should be given artificial respiration by a trained person to revive his respiration This can be done by mouth to mouth resuscitation. If the person has got some burn due to sparking or coming in contact with high tension line first aid for the burns may be given only after artificial respiration has been given to restore his normal breathing In case heart of the victim also stopped due to electric shock he may be given a heart message along with artificial respiration simultaneously

Equipment and Materials

(i) Rubber sheet 1/2" thick 4' x 3' size

(ii) Rod or dry wood, bakelite or fibre

(iii) Cotton mat

(iv) Towel or a sheet of cloth

(v) Pair of rubber gloves

Procedure

A. To disengage a person from the contact of live electrical part

(i) First simulate the condition as if a person has come in contact with a live naked wire with his hand gripping the conductor.

(ii) Now try to locate and switch off the current from the imaginery switch supplying current to the live wire

(iii) Spread the rubber sheet on the ground near the victim and try to disengage him with your hand wearing rubber glove

(iv) Alternately try to disengage the person from the contact of the live conductor with the help of dry wodden/backelite rod or by pulling his cloth if they are not wet.

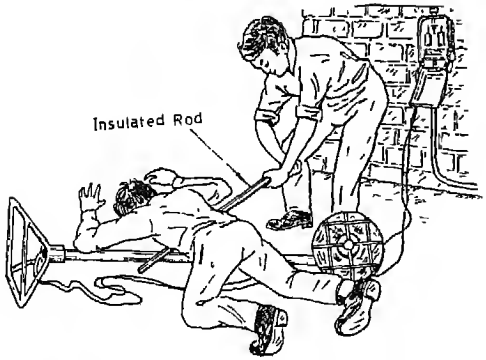


Fig. 3 1 Disengaging a person from live part

B. Electrical shock treatment

Artificial Respiration

(i) Spread a cotton sheep or mat on the ground and place the victim on this back on the sheet.

(ii) Lift the head all the way back and place a rolled towel under his neck and press the top of the head backward

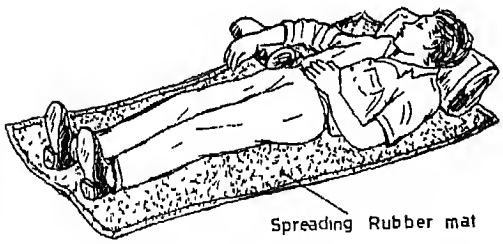


Fig 3.2 To lay victim on his back

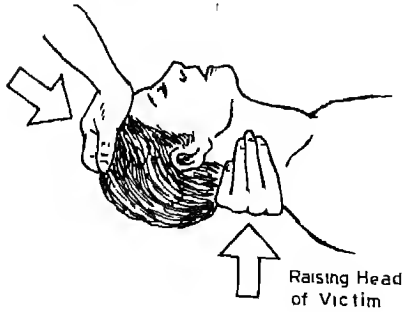


Fig 3 3 Lifting the head way back

(iii) Remove ar y obstruction from the mouth

Fig. 3 4 Removing any obstruction from mouth

(iv) Pinch nose and blow vigorously through the mouth to make chest expand.

(v) Inflate 12 times per minute without interruptions

(vi) If chest does not expand, the victim may be turned on his side He may be given several blows by the palm of your hand between the shoulder blades Recheck as in term (iii) and resume blowing

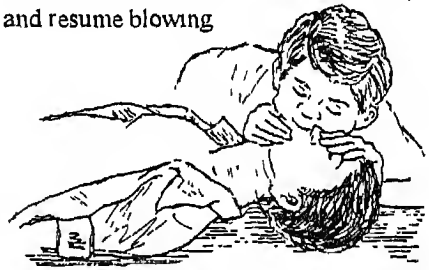


Fig. 3.5 Pinching nose and blowing through mouth

The above process is known as mouth to mouth resuscitation and very easy to administer

C Treatment of burn sustained during electrical accident. Same as first aid offered to victim of burn injury caused by fire hazard.

Precautions

(i) While disengaging a person from live electric conductor do not allow any part of your body to make contact with victim's body

(ii) Before giving artificial respiration, loosen the clothes of the victim near his neck, chest and waist

(iii) If there are severe burns then don't try to remove the burnt cloth or burnt skin scales

of the victim

(iv) If during the electrical accident the victim has sustained burns and his breathing has also stopped first give him artificial respiration then go for first aid for burn injury

(v) Call a medical person or remove the victim to a hospital as soon as possible after restoring his breathing and first aid is given

(vi) Do not make fuss or panic but act promptly but coolly

Questions

(i) What is the minimum current that causes tightening of body muscle in case of electric shock ?

(ii) What step will you take first when you find a person who has come in contact with or gripped a live conductor?

(iii) What action will you take first after disengaging a person from live electrical parts if you find he is not breathing and he has also got burn injury during electric shock?

(iv) Will you allow the person to go home after his condition has been revived by giving artificial respiration and first aid has been given?

ACTIVITY 4

To Study a First Aid Box

Specific Objective

To identify contents of a first aid box and use them as and when required.

Related Information

First aid is the immediate assistance that can be given to a person suddenly fell ill at work This assistance is rendered with limited resources available at site by non – medical persons for recovery of the injured/ill person, to prevent worsening of his condition and at times save his life before removal to hospital It should be kept in mind that first aid is not a substitute to medical treatment but only the initial action

First aid boxes are provided to work site for emergency treatment/precaution. These are portable boxes made of sheet metal or galvanised iron sheet with easily detachable top covers There are trays and compartments for keeping medicines and bandages The following items are kept in a first aid box·

(i) Detol – 1 bottle small – 50 ml
(ii) Boric acid – 50 gram
(iii) Rectified spirit – 50 ml
(iv) Mercurochrome lotion – small bottle
(v) Potassium permanganate – 50 gm
(vi) Tincher iodine – 25 ml
(vii) Aspirin tablet – 50 nos
(viii) Paracetamol tablet – 50 nos
(ix) Avomin tablet – 25 nos
(x) Sulphaguandine tablet - 25 nos
(xi) Cibazol tablet – 25 nos
(xii) Codopyrene tablet – 25 nos
(xiii) Smelling salt – 10 gm
(xiv) Sterilized surgical cotton – 1 roll
(xv) Assorted adhesive dressing – 25 nos
(xvi) 1" roller bandage – 3 roll
(xvii) 3" roller bandage – 3 roll
(xviii) Triangular bandages - 5 nos
(xix) Scissor 5" (blunt pointed) – 1 no
(xx) Medicine glass (graduated) – 1 no
(xxi) Safety pin – 1 doz
(xxii) Thermometer (clinical) – 1 no
(xxiii) Small torch with cell – 1 no
(xxiv) 6" kidney basin – 1 no
(xxv) Dressing forcep – 1 no
(xxvi) D.B knife – 1 no
(xxvii) Lancet – 1 no
(xxviii) Note book – 1 no
(xxix) Pencil – 1 no
(xxx) Glucose – 100 gm
(xxxi) Rubber Tourniquet – 1 no
(xxxii) Set of splints with metal connections – 1 set
(xxxiii) Split straps for securing splints in lieu of bandages

Equipment and Materials

First aid box complete with contents

Procedure

(i) Place the first aid box on a table or clean paper and open the cover
(ii) Remove the top tray.
(iii) Take out all the contents from the trays and compartment, place them on the table
(iv) Make a list of the content and their quantity in tabular form

Tabular Record of Observation

Sl No	*Name of Item*	*Quantity*	*Use*

(v) Learn the use of each item and record them in the table

(vi) Keep all the items back at their respective place Replace the top tray Shut the first aid box cover

(vii) Carry the first aid box for some distance carefully so that contents may not get damaged/mixed

Precautions

(i) First aid box must be carried without jerk

(ii) Hands must be clean and dry for opening first aid box.

(iii) The bandages must not be placed on ground

(iv) Medicines should be taken out only after entering in the note book.

Questions

(i) Why detol/potassium permanganate and boric acid are provided in the first aid box ?

(ii) When tourniquet is used ?

(iii) List pain killer medicines provided in the first aid box

ACTIVITY 5

To Practise First Aid

Specific Objective

To give first aid to affected person in case of (i) bleeding wound (ii) first degree burn (iii) in a state of shock and unconscious state.

Related Information

First aid is the immediate assistance that can be given to a person injured or suddenly fallen ill at work site, before he is transferred to look after by a doctor Purpose of first aid is to prevent worsening the condition of the injured/ill person before he is presented to a doctor for treatment It is a very important activity as it gives immediate relief to the victim and also some time help to save his life Time is a very important factor in first aid The action taken in first aid should be prompt and without creating any fuss and panic The moral of the injured should be boosted by reassuring him while giving first aid

Profuse bleeding, first degree burn and state of shock, fracture are the indications for which first aid can be given. If there is indication, visible manifestation of broken/fractured bone, position of broken limb should not be disturbed and qualified doctor should be called

A Severe Bleeding

Any wound which is profusely bleeding in any part of the body must be considered serious Immediate first aid is given to check the bleeding To apply direct pressure on the wound through clean cotton pad and roller bandage is the best method of stopping bleeding and avoiding infection Bleeding can be prevented by applying direct pressure on the pressure points on the victim's body If there is any metalic or nonmetalic chip in the wound do not try to remove it

B. First Degree Burn

Burn is a injury caused by dry heat, piece of hot metal, contact with high tension electric current, electric sparking etc Any burn which is confined to the surface of skin is known as first degree burn Burn which penetrates deep in skin and muscle are known as second and third degree burn First degree burn can be easily identified as it causes only reddening of the portion on the surface of the skin where burn has occurred In 2nd and 3rd degree burn the skin/tissues may get blackened or charred First aid can only be given to a first degree burn injury No first aid is to be given in case of 2nd and 3rd degree burn at work site In such case burnt portion should be kept covered with sterilised or clean dry cloth before victim is shifted to hospital

C Eye Irritation

If the victim complains irritation in eye and it appears that there is some metal chips in the eye don't allow the eye to be rubbed You can make loose light bandage by clean cloth across the eye to prevent rubbing

D State of Shock

Shock is a condition of sever depression of

vital function It is associated with changes in circulatory system varying from temporary weakness to complete failure First aid action in shock treatment is to reassure the victim and cover him with a blanket or rug after laying him down on his back He may be given sip of water, tea, coffee etc if the victim complains of thirst However if the victim is in unconscious state don't give any sip of liquid

Materials Required

(i) First aid box consisting of standard items
(ii) One enamelled surgical tray 8"× 6" size
(iii) Bucket full of clean water
(iv) One plastic mug

Procedure

A. To check bleeding

(i) Make the injured person lie down and rest
(ii) Raise the injured part from the level of the body
(iii) In case of small wound, wipe off/clean dirt

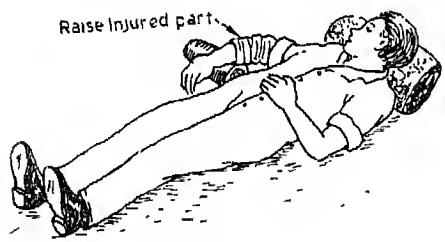


Fig. 5.1 Lay patient down

and dust by a lump of cotton soaked in detol or potassium permanganate solution
(iv) Press the edge of the wound together and put a clean pad of cotton on it and bandage it with roller bandage.
(v) In case of larger wound apply clean pad and bandage firmly in place

B. First Degree Burn

(i) Bring a tray full of cold water and place it beside the burnt person.

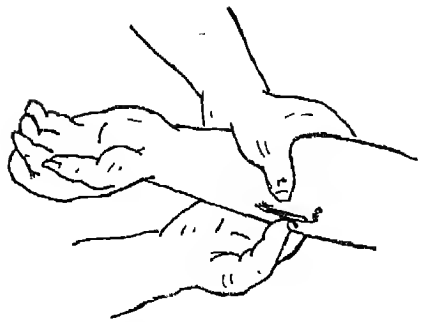


Fig 5 2 Apply pressure to the wound

(ii) Dip the portion of the limb which has got a first degree burn in the tray so that burnt portion remain well under water
(iii) Leave in this position for half an hour
(iv) After the above operation wipe off the burnt

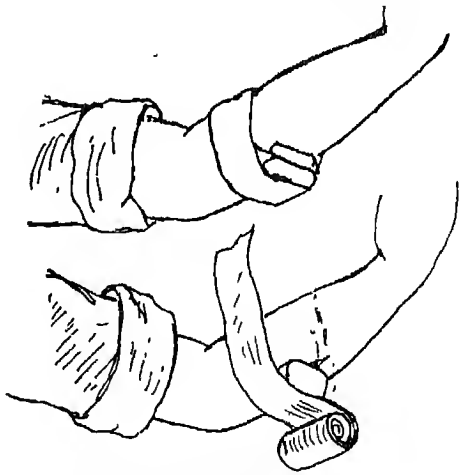


Fig. 5.3 Method of pressure bandaging

portion and cover with dry clean or sterilised cloth
(v) In case you can not dip the burnt portion pour water over the burnt portion slowly from a mug for some time and wipe and cover the burnt portion

C State of Shock

(i) Reassure the person under shock if he is in

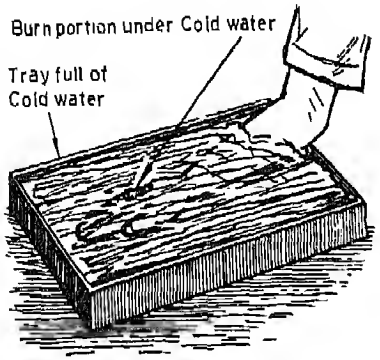


Fig 5.4 Soaking the wound in cold water

conscious state.

(ii) Lay him on his back with his head low and turned aside (if there is no injury on head).

(iii) Loosen the clothing about the neck/chest/ waist

(iv) Cover him with a blanket or rug

(v) A sip of water or hot tea, coffee may be given to the victim. Never give liquid sip to a victim in unconscious state

Precautions

(i) Don't create fuss and panic while rendering first aid

(ii) Don't allow crowd to gather around the victim.

(iii) Persons offering first aid should first get their hands washed/cleaned by some disinfectant solution

(iv) In case of burn it should be taken care that the clean cloth which is used for covering the burn do not exert any pressure on the burn wound

(v) If there is visible manifestation of broken bone don't move the affected limb of the victim till expert service is available.

(vi) In case of a person under shock do not try to heat up his body by rubbing/warm water bottle etc

(vii) Do not allow the victim to rub his eye if you suspect some metal/non metalic chip has creeped in the eye during injury

Questions

(i) What action will you take when you find an injured person bleeding profusely ?

(ii) How do you differentiate between a first degree and second degree burn?

(iii) Do you move the limb of a victim to arrange it properly when you have observed that some bone has got broken and protruded out from the wound?

ACTIVITY 6

To Study Fire Extinguishers and their Application

Specific Objectives

(i) To get familiarized with different type of fire fighting equipment

(ii) To learn the application of fire fighting devices

Related Information

Fire is caused when three agents i e heat, air and combustible materials come in contact with each other To extinguish a fire attempt is made to separate the above agents by different means. For this a fire extinguisher is used It is a portable device It can be used at initial stage of fire in the shop floor till the fire fighting personnel arrive with their larger gear

For fighting fire hazards in electrical motor repairing shop following portable fire fighting extinguishers are used

(i) Soda Acid type

(ii) CO_2 type

(iii) Dry chemical powder type

(iv) Fire buckets filled with sand or water are also kept as fire aid in small establishment

(i) Soda Acid type fire extinguisher This type of extinguishers are used for fighting 'A' class fire i e fire of combustible substances like wood/ paper/cloth/cotton waste/jute etc In Fig 6 1 different parts of a soda acid type extinguisher have been shown

The extinguisher consists essentially of a cylindrical or conical container which is normally filled with water to an indicated mark This water is ejected on to the fire by pressure of a gas generated by a chemical action set up by

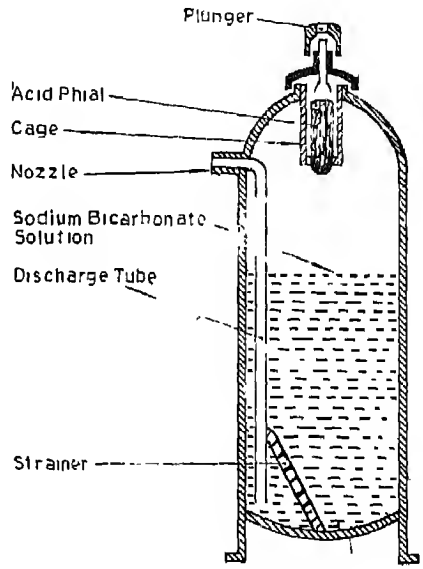


Fig 6 1 Soda Acid type extinguisher

allowing a charge of acid to react with a carbonate or bicarbonate which has previously been dissolved in water The gas thus generated exerts a downward force on the surface of the liquid and drives it out of the extinguisher through a nozzle. Sodium bicarbonate and Sulphuric acid are the two chemicals normally used for generating the gaseous dioxides which is used as expelling medium.The reaction takes place according to the equation

$2Na\,HCO3 + H_2\,SO_4 = Na\,SO_4 + 2H_2O + 2\,CO_2$

Na HCO3 = Sodium Carbonate

H_2SO_4 = Sulphuric acid
SO_4 = Sodium Sulphate
H_2O = Water
CO_2 = Carbon Dioxide

(ii) CO_2 type extinguisher This type of extinguishers are used for extinguishing class B and C type of fire – i e fire of oil, petroleum product, gases and electrical and electronic equipment In Fig 6 2 the different part of a CO_2 type extinguisher has been shown

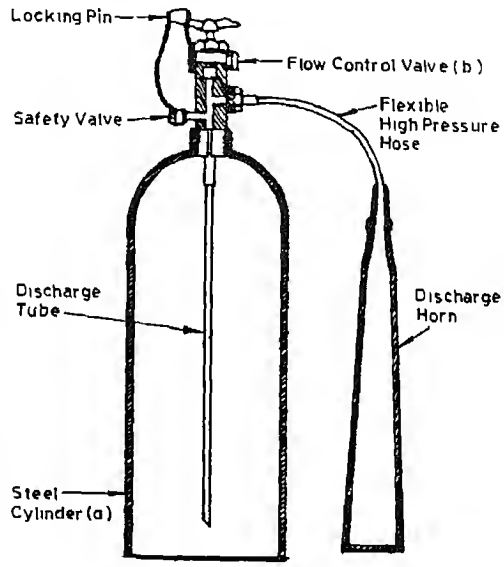


Fig. 6.2 CO_2 type extinguisher

This extinguisher consists of two principal parts (i) A steel cylinder which contains the liquid CO_2 gas, the cylinder is fitted at the top with a sealing disc and piercing or valve mechanism, (ii) A discharge horn which in smaller model is rigidly connected to the valve mechanism and in larger sizes is connected by flexible high pressure hose The cylinder is normally filled with liquid CO_2 approximately two third by weight of its water capacity The disc may be pierced in some model by knocking in the plunger at the head of the cylinder and in others by a lever device or opening a valve

(iii) Dry chemical powder type extinguisher This type of extinguisher is suitable for extinguishing B, C and E type fire i e fire in petroleum product, paint, natural gas and fire in electrical equipments like transformers, switch gears etc In Fig 6 3 the detail of a dry chemical powder type extinguisher has been shown

In this type of extinguisher CO_2 at high pressure is kept in a sealed cartridge which can be pierced or broken by a mechanism similar to CO_2 type extinguisher The main compartment of the extinguisher is filled with dry chemical powder which can be discharged through a rubber hose fitted with nozzle When the seal of the CO_2

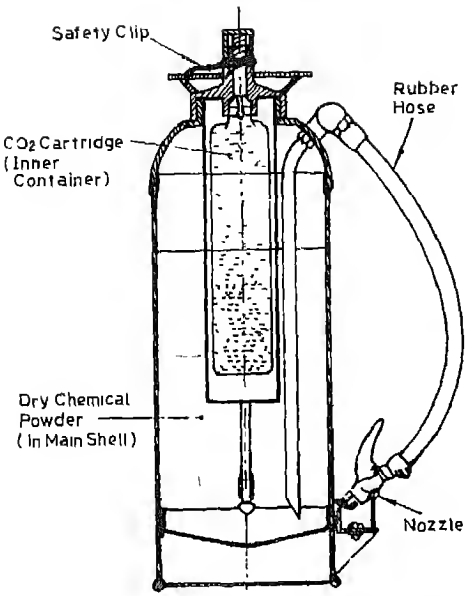


Fig. 6 3 DCP type extinguisher

cartridge is broken the gas come down at the bottom of the main compartment through CO_2 inlet pipe and discharge the chemical powder of sodium/ potassium and barium compounds in form of dense cloud through the nozzle of the rubber hose which extinguishes the fire

(iv) Fire buckets painted in red colour and marked "FIRE" are kept in stands at easily approachable place, generally these buckets are filled with sand for smothering fire But once sand is exhausted water can also be carried by this bucket to extinguish fire

Equipment and Materials

(i) Soda acid type extinguisher
(ii) Carbon dioxide type extinguisher
(iii) Dry chemical type extinguisher
(iv) Some dry combustible material like wood shaving, cotton, jute soaked in oil.
(v) A big tray containing lubricating oil mixed with a bit of Kerosene oil.
(vi) Fire buckets filled with sand

Procedure

Application of Soda Acid type Extinguisher

(i) Light up a mock fire in a open space by kindling a heap of wood shaving/paper/ cotton waste.
(ii) Now bring the soda acid type cylinder near to the fire
(iii) Remove the guard cap and struck the plunger in the ground. Water will start gushing out of the nozzle
(iv) Train the water shower at the bottom side of the fire and gradually direct it from bottom to top
(v) Soda acid type extinguisher cools down the heat of the fire thus causing it to extinguish

Application of CO_2 type Extinguisher

(i) Light up a mock fire of luboil and kerosene oil mixture on a big tray placed in a open space.
(ii) Bring the CO_2 type extinguisher and remove its safety pin
(iii) Operate the lever or valve for ejection of CO_2 through the discharge horn
(iv) Train the discharge horn towards lower portion of the fire and turn it from left to right so that the carbon dioxide blowing out of the horn strike the fire at the lower portion

Application of Dry Chemical Power Extinguisher

(i) Light up a mock fire
(ii) Bring the extinguisher and remove its safety pin.
(iii) Strike the knob which will break the sealed disc of the CO_2 cartridge and a dense fog of Dry chemical powder will be discharged through the hose nozzle
(iv) Train the flow of the dry powder cloud

towards bottom level of fire from a distance of 7 to 8 ft and gradually step towards the fire with turning the ejecting nozzle from left to right

Application of Fire Bucket

(i) Carry the fire bucket filled with sand near the fire
(ii) Stand at about 4 feet away from fire
(iii) Take handful of sand from the bucket, and go on throwing the sand on the fire starting from the edge and gradually towards centres of the fire.
(iv) Repeat the operation going round the fire till the fire is contained
(v) When sand has totally exhausted bring water from the nearest water source to sprinkle water on the fire in the same manner to smother the fire

Precautions

(i) Whenever go for extinguishing electrical fire first of all ensure that the system has been deenergised by switching off the incoming switch
(ii) Whenever fire is to be extinguished in open place always train the water/CO_2/dry chemical powder towards the fire standing in the direction of wind for obtaining good result Similarly while sprinkling water try to avoid steam stroke so generated
(iii) The extinguishers should be periodically checked to ascertain the soundness of their system and the chemicals provided in the particular type of extinguisher have not leaked out or discharged before hand If so arrange to recharge them

Questions

(i) What is the difference between a soda acid and CO_2 types of extinguisher?
(ii) What type of extinguisher will be used to put out the fire of heap of cotton waste and wood shaving ?
(iii) What are the three agents that cause a fire?
(iv) What precautions will you take to extinguish a fire in 415 V switch gear?

ACTIVITY 7

To Practise House Keeping of Motor Repair Shop

Specific Objectives

(i) To observe house keeping provisions in repair shop
(ii) To identify the violation of house keeping rules and to correct the same

Related Information

House keeping is a method of keeping the work site neat and tidy in a systematic manner Proper house keeping will reduce hazards like fire, injury to worker due to fall, striking against object, struck by some falling material, etc As such house keeping is also called safe keeping

Proper house keeping improve the work environment to a level where work will be a pleasure instead of drudgery to a worker House keeping helps creating a work situation where worker will not find any hindrance to normal movements required for discharging his duty This in turn will improve productivity House keeping also reduce avoidable wastage of time and material House keeping is not the responsibility of an individual It is the mutual responsibility of all persons working in a particular work place/shop

For proper house keeping management should ensure adequate work space, illumination and ventilation in the work area

The foreman, incharge of a workshop should see that all the devices fitted in the workshop for illumination/ventilation, etc are maintained properly Individual workers should keep their work site neat and tidy, workers should inculcate the habit of detecting house keeping violation and correct them to avoid any hazard caused to him or his fellow worker And if correction of any house keeping violation is beyond the scope of a worker, he should report it to his superior for early correction

Materials

(i) Paper
(ii) Pencil

Procedure

(i) Observe the general cleanliness of the workshop
(ii) Detect if there is any loose electric wire hanging from any switch board/mechines etc which may be touched during movement by a worker.
(iii) Observe if all the electrically operated machine drives are properly earthed or not
(iv) Observe whether 3 pin plug has been provided with each of the leads of electrical hand tools like blower/hand lamp/portable drill machine etc
(v) Observe whether leads of the welding machine/motor generator set has been coiled properly and kept away from passage
(vi) Observe if the lead of any electrically operated tools lying across the passage which may stuck up in the leg of any body stepping there and trip him.
(vii) Observe if there are any liquid splash on the floor (like lub oil/paint/varnish/water/grease) where person moving may get slipped

(viii) Observe whether bins have been placed beside each working bench for dumping burnt winding wire/insulation material scrap/paper and other waste

(ix) Detect if there are any heaps of easily combustible material like wood shaving/ paper/oil soaked cotton waste/plastic scrap inside the workshop area

(x) Observe how the liquid consumable material like insulation varnish/paints/k oil grease, etc for use by the worker has been kept and also whether above liquid's containers are suitable

(xi) Observe how the rotors of big motors (disassembled) has been kept and whether their shafts are projecting on the passages against which any body may strike.

(xii) Observe whether metal pieces/nuts and bolts, small motor parts are lying scattered on the workshop floor and passages

(xiii) Observe whether during work the workers have left their hand tools scattered on the floor

(xiv) With the permission of your instructor try to correct as many of the anomalies you have observed, if you can do it yourself or take the help of fellow student

Precautions

(i) Keep your eye open during detection of house keeping violation (keep alert)

(ii) Take care that you may not get involved in any hazard during detection/observation of house keeping violation

(iii) Do it quietly and without any fuss

(iv) Do not initiate any corrective action without intimating your instructor/supervisor

(v) Take help of your fellow student/worker for the corrective action which can not be done alone

Questions

(i) List out the house keeping violation you have observed in the workshop?

(ii) What action will you take if you have found a patch of Lubrication oil splash on the floor of workshop ?

(iii) What action will you take if you find a broken electrical wire touching the body of a machine and sparking ?

Identification of Common Hand Tools, Equipment and Instruments

Specific Objectives

(i) To identify different types of hand tools, equipment and instruments
(ii) To get acquainted with the use of different hand tools, equipment and instruments.

Related Information

To carry out repair and maintenance of electrical motors various mechanical functions like hammering/marking/measuring/fastening/binding/twisting/jointing/cutting/shaping/grinding/sawing/chipping/scrapping/hauling/levering/threading are to be carried out Similarly before, during and after the repair of a motor, good number of testing has to be carried out to determine the electrical behaviour of a motor, its components and materials used for repair Different types of hand tools and electrical instruments are the aids with the help of which a work man performs the above mentioned functions and testings.

Before initiation to the electrical motor repair work the student must get acquainted with different hand tools/instruments and their use for particular function.

Function wise classification of hand tools and instruments as described hereafter will help in giving insight to the different tools and their use.

Materials and Equipment

(i) Screw drivers assorted
(ii) Spanners – 1 set
(iii) Different types of pliers
(iv) Tincutter/wire cutter/hacksaw/scissor
(v) Files assorted
(vi) Wooden saw
(vii) Hammer
(viii) Centre punch /steel measuring tape/wire gauge/feeler gauge
(ix) L N key set
(x) Chiesel
(xi) Wire scrapper/cable stripper
(xii) Crowbar
(xiii) Solder iron
(xiv) Portable electrical drill machine
(xv) Electric blower
(xvi) Grease gun/oil can
(xvii) Steel sling/D shackle/Manila rope
(xviii) Line tester
(xix) Multimeter/ammeter/voltmeter/ohmmeter
(xx) Meggar insulation tester
(xxi) Wheat-stone bridge
(xxii) Crimping tool

Procedure

(i) Take out hand tools from rack/tray and put them properly on a table or a clean place
(ii) Make a list of all mechanical hand tools after identifying each of them and know their use
(iii) Make a list of all electrical equipment after identifying each of them and know their use
(iv) Measure the size of each of assorted screw drivers/spanners and other small hand tools
(v) Write down the specification and range of each of the electrical instruments from their name plate, otherwise by measuring the parameters
(vi) Draw free hand sketches of the tools displayed to you

Function-wise names of different hand tools and equipments

Name of function/operation	*Name of hand tools to be used for the operation*
Hammering/Striking	Hammer (Bal pein/Sledge hammer)
Holding	(i) Vices (ii) Pliers (iii) Tongs
Marking/Measuring	(i) Centre Punch (ii) Steel scale (iii) Steel measuring tape (iv) Screw gauge (v) Feeler gauge (vi) Wire gauge (vii) Spring balance
Binding/Twisting/Jointing	(i) Insulated combination pliers (ii) Long nose pliers (iii) Soldering iron
Fastening/Unfastening	(i) Screw drivers (ii) Wrenches (iii) Spanners (iv) L N Key
Cutting	(i) Tin cutter (ii) Cutting plier (iii) Hack saw (iv) Power saw (v) Scissor (vi) Knife
Shaping/Grinding/Machining	(i) File (ii) Grinder (iii) Shaper machine (iv) Lathe machine
Sawing	Wodden saw
Chipping	Cold chiesel and striking tools
Scrapping	(i) Wire scrapper (ii) Cable stripper
Thread cutting	(i) Tap and dieset (ii) Lathe machine
Hauling/Hoisting	(i) Snatch block (ii) Steel sling (iii) Manila rope (iv) Over head travelling crane (v) D shackle
Levering	Crow bar
Cleaning/Blowing	(i) Electric blower (ii) Vacuum cleaner
Oiling/Greasing	Grease gun/oil can
Heating	(i) Blow lamp (ii) Solder iron
Drilling/Boring	(i) Drilling machine

Name and use of Electrical Instruments and Equipment

S No	*Name of Instrument*	*Use*
(i)	Line tester	To check presence of electrical supply (single phase)
(ii)	Volt meter	To measure voltage
(iii)	Ammeter	To measure current
(iv)	Ohmmeter/Wheatstone bridge	To measure resistance
(v)	Multimeter	For measuring current/voltage resistance
(vi)	Tong tester (clip on meter)	To measure current/voltage of cable
(vii)	"Meggar" Insulation Resistance tester	To measure insulation resistance
(viii)	Phase sequence meter	To check phase rotation of 3- phase motor
(ix)	Crimping tool	For cable termination with lugs

(vii) Understand the uses of hand tools under guidance of your instructor
(viii) Clean all the portable tools and know how oil/grease is filled in blow lamp/grease gun/ oil can

Precautions

(i) While taking out the hand tools on table see that the tools do not collide with each other
(ii) Keep the electrical instruments on a separate table away from the table where hand tools have been kept.
(iii) See that during handling hand tools do not fall on the ground or strike against any hard object as these may damage the tools
(iv) Replace the handtools carefully after studying the same and also take care that they do not bang with other tools during replacing
(v) Do not try to use any hand tools till you know the proper method of using
(vi) Handle the tools one at a time.
(vii) Beware of the naked metal parts of the electrical instruments when your instructor demonstrates their use on live line

Questions

(i) What hand tools will you use for marking the position of holes on an iron plate ?
(ii) For what purpose a screw driver is used ?
(iii) What hand tool will you use for heating a copper bar ?
(iv) Which electrical instruments will you use for measuring resistance of a electric lamp?
(v) What is a crimping tool, for what purpose is it used ?
(vi) What precaution will you take during handling of hand tools ?

Use, Care and Maintenance of Common Hand Tools, Equipment and Instruments of Electrical Motor Repair Shop

Specific Objectives

(i) To acquire skill in use of common hand tools and electrical instruments
(ii) To care and maintain common hand tools and instrument

Related Information

A good number of common hand tools are used in motor repair shop Students should know the correct use of each type of tools and their proper handling and care Tools not handled carefully develop defects which may cause injury to the worker and also damage the equipment and components on which these types of tools are used For hand tools which may be used some time for working on live electrical parts, due care should be taken so that the insulations provided in such tools are in good condition All tools should be periodically checked in routine manner to find out damage caused to them due to normal wear and tear and also for careless handling. Such damaged defective tools may be attended or replaced by new one at the earliest opportunity. Bad tools may result in bad jobs and delay in completion of a job When a number of tools are required for performing a job, student should make a list and count the tools before starting work During work due care should be taken so that the hand tools are not scattered hither and thither around the job The tools should be placed neatly arranged on a tray or can. Each tool may be placed at its proper place after use This will prevent missing of small tools It will also prevent any damage to the tools due to falling on some hard object/surface. After completion of work all the tools should be cleaned and counted before returning to store Student should inculcate the habit of using the right type and size of tool for performing a job They should never use a tool to perform the job of another tool When work is going at any elevated place hand tools should not be thrown up from below In such case, rope line should be used to carry the tools at job site at elevated level When a number of tools are required for such situation a can/tool kit containing the tools may be tied to the rope line. Before working with electrically operated hand tools student should ensure that metallic body of such tools do not give shock due to leakage current Ensure that insulations of the power leads to electrically operated tools are in perfect order The leads are fitted with proper type of plug top which get tightly filled in the power plug base Before using any electrical measuring instruments proper ranges may be set which should be double of the maximum value of parameters to be measured

Application and Care of Hand Tools and Instruments

(i) Screw driver It is a simple tool used for opening and tightening screws/small bolts. During application the screw driver stem should always he held perpendicular to the screw head Force is applied on its handle to press against the head and to turn it For electric work the handle and blade of screw driver should be properly insulated If the handle or edge of the blade of

screw driver is broken, it should not be used to avoid injury Never strike handle of screw driver with a hammer for any work

(ii) Spanner/wrench . This tool is used for tightening or loosening a nut or a bolt During application right size of spanner be selected to match the size of nut/bolt While opening and tightening a nut due care should be taken that wrench stem is held horizontally and then turning force is applied. An oversize wrench may not be used to open a smaller nut with aid of packing Different types of wrench like D E spanner/ring spanner/screw wrench/slide wrench/pipe wrench/ box spanner/tubular spanner are used for opening nuts and bolts fixed at different situation in a machine Never use the spanner as a hammer if hammer is not readily available

(iii) Pliers ; It is a versatile tool used for electrical work for cutting, twisting, jointing, holding or pulling The handle of the pliers used for electrical work are well insulated The cutting edge of the pliers should not be used to cut hard metal wire of iron and steel Pliers should never be used to strike any object as this will loosen the fastener of its jaws Combination pliers, cutting pliers, long nose pliers, gas pliers are used for different operations on electric machines and equipment

(iv) Hammer · This tool is extensively used in electrical workshop for tapping, striking any component, for loosening or fixing It is also used for driving one component to another component and breaking worn out, burnt material or component Before using a hammer check that its handle is not loosely fitted and the hammer head has not got frayed and chipped to avoid injury While striking any object or component give smart blows of the hammer in such a way that it strikes the desired spot perpendicularly

(v) Tin cutter ; This tool is used for cutting thin metal sheets

(vi) Scissor: This is used for cutting papers and different types of insulating sheets/clothes and tapes

(vii) Centre punch It is used for marking on metal sheet before drilling holes

(viii) Feeler gauge· It is used for measuring very small clearances provided between different components of machine It consists of a number of finely machined thin steel leaf hinged between two steel strips , The leafs of feeler gauge are arranged in such a way that one or more leafs can be used at a time to measure any gap

(ix) Wire gauge ; This tool is used to measure the diameter of conductor, thin wires and thickness of sheets It is a steel disc with different size holes along its periphery Slits are cut to each hole through which wires could be placed in the holes to measure their diameters

(x) Hacksaw ; This is a portable tool which can be used to cut thin metal sheet/rods, insulating boards/sheets/rods of backelite, fibre/ebonite, etc It has a frame in which an easily replaceable blade can be fitted

(xi) Electrical blower/vacuum cleaner ; This electrically operated portable tool can be used for removing dust from machine parts which cannot be approached easily

(xii) Multimeter ; It is a versatile electrical measuring instrument used extensively in electrical workshop It is very handy and can be used by an electrician with a short breiting Voltage/current/resistance can be measured by this instrument. Before going for measurement of a particular element the appropriate selector switch and range switch should be set. With the two flexible leads fitted with pointed spikes any two points in a machine can be connected and magnitude of voltage/current/resistance can be measured As the measurement indicates Amps/ Volts/Ohms the instrument is also called AVO meter

(xiii) Insulation tester : It is used for measuring insulation resistance of electrical machines and cables The measured values are indicated in Kilo ohm/Megohm It has two leads which are to be connected across the insulation of a compo-

nent whose insulation resistance is to be measured A handle is rotated to operate the generator fitted inside tester to drive current across the insulation for measuring resistance

Procedure

(i) Practise use of each of the above tools and instruments under the guidance of your instructor

Precautions

(i) Handle tools and instruments carefully
(ii) Do not handle any instrument unless and until you are conversant with its use
(iii) Always use the right type and size of tools for a particular job
(iv) During work take care that the tools do not slip/fall from your hand and get damaged
(v) After completion of job, clean your instrument/tools and place them at their proper place

Questions

(i) What care will you take during use of a screw driver ?
(ii) Where will you use an electric blower for cleaning purposes ?
(iii) What step will you adapt for measuring the resistance of an electric lamp using multimeter ?

To Study the Operation, Application, Care and Maintenance of Machines Used in Electrical Machine Repair Shop

Specific Objectives

(i) To achieve faultless and safe working on machine
(ii) To increase service life of machine
(iii) To acquire knowledge about the specific use of different machines in the workshop

Related Information

Electrical machine repair shop is having various machines for different repair work. This includes machines for electrical repair, machines for mechanical repair and machines for cleaning and surface painting, etc Repair-shop machines are listed below

(a)Machines for electrical repair

(i) Coil winding machine for making coils
(ii) Impregnating plant for impregnating the machine insulation.
(iii) Electric oven for baking

(b) Machines for mechanical repair

(i) Portable and bench drill machine for drilling
(ii) Portable and bench grinders for grinding
(iii) Lathe machine for turning keyhole making ,etc
(iv) Circular wood cutting saw for insulation cutting
(v) Electric welding set for welding purposes

(c) Machines for cleaning and painting

(i) Vacuum cleaner for removal of dust and dirt
(ii) Spray painting machine for surface painting
(iii) Grease gun for lubrication

(d) Machines for material handling

(i) Suitable crane for handling heavy parts
(ii) Chain pulley block for part handling/shifting machines
(iii) Trolley for material transportation

To keep the machines and equipment in healthy working condition and also to increase their working life, their care and maintenance is essential Maintenance of machines is "must" and can be termed as an insurance for trouble performance of the equipment.

Types of maintenance

(i) Preventive maintenance
(ii) Break down maintenance

Periodic inspection of the equipment to find conditions leading to break downs and harmful depreciation is known as preventive maintenance Up keep of equipment with a view to neutralising such conditions or repair of defects which may impair the functioning of the plant is known as break down maintenance

(i) Inspection for faults so that the probable causes of breakdown can be found out
(ii) Servicing Three operations are performed in servicing
  (a) Cleaning and brushing
  (b) Adjustment
  (c) Lubrication

Work to be done

Name of M/c	*Cleaning*	*Instruction*	*Lubrication*	*Overhauling*

Check-List

S No	*M/c*	*Parts*	*Date of inpection*	*Position* ✓ *or* ×	*Remark*

(iii) Overhauling
Periodic overhauling is necessary to increase the service life of equipment and to increase the efficiency of equipment The steps of overhauling include acceptance test, dis-assembly, reconditioning or replacement points, reassembly, lubrication and finally acceptance list before installation or correcting with electrical supply.

Procedure

(i) Note the instruction given in the instruction booklet supplied with the machine In case it has not been proposed take help of I S codes or standard reference books
(ii) Note the testing sheets of the machine, i e, make, date of installation, surface life, repair work done and special precaution to be taken for its handling
(iii) Prepare a preventive maintenance chart as below and proceed accordingly
(iv) For inspection of fault use a check list in order to avoid confusion and to ensure that no part is left uninspected

Precautions

(i) Ensure that every m/c is inspected regularly. It should be cleaned before and after the work
(ii) Unnecessary inspection is also dangerous Do not play with machines
(iii) Before maintenance check that the electrical supply is off
(iv) Do not work with running machine
(v) Observe safety rules

Questions

(i) What do you mean by maintenance and care of machines ?
(ii) How is a check list useful for the care and maintenance of machine?
(iii) What precautions should be taken for smooth functioning of the machine ?
(iv) List the machines used for repair of electrical machine
(v) List the work to be done under preventive maintenance

To Study Low and High Resistivity Conductor and Brush Materials

Specific Objectives

(i) To differentiate between low and high resistivity materials
(ii) To identify common low resistivity materials
(iii) To identify common high resistivity materials
(iv) To identify brush materials
(v) To explain common characteristics and application of low and high resistivity conductor and brush materials

Related Information

Various low resistivity materials are used as conductor wire, coils of electromagnets, fuse elements, etc The resistivity range of low resistivity materials is between 10^{-8} ohm-m to 10^{-7} ohm-m

Such materials are known as conductor materials The common conductor materials, with their characteristics and applications are as below

Copper Copper is reddish in colour and can be available in hard drawn or annealed form Mechanical properties are different for hard drawn and annealed copper. Copper can be drawn into very thin wires, sheets and bars of various thickness can be made It has following properties –

Temperature coefficient of resistance at 20°C - 0 00393°C

Tensile strength -8 15 to 8 72 tonnes/cm^2

Copper offers high resistance of corrosion because of the formation of copper oxide

Copper can easily be soldered and welded.

Copper joints offers low contact resistance Applications of copper is given below

Hard drawn copper	*Annealed copper*
(i) Density 8 93	8 89
(ii) Melting point 1084°C	1084°C
(iii) Resistivity 1 77 × 10^{-8}	1 72 × 10-8
(iv) ohm-m at 20°C	ohm-m at 20°C

(A) Hard drawn copper
  (i) Over head conductor
  (ii) High voltage under ground cable
  (iii) Bus-Bar
(B) Annealed copper
  (i) Insulated conductor in low voltage power cable
  (ii) Winding wire for electrical machine and transformer
  (iii)Flexible wire in making coils for many purpose

Aluminium Aluminium is widely available in India and is used extensively in the field of electrical engineering. It has following properties

(i) It is very cheap and lighter in weight
(ii) Resistivity of aluminium is 2 8x10-8 ohm-m (that is about 1 6 times higher than copper)
(iii) Density - 2 68 (that is aluminium is much lighter than copper)
(iv) Melting point - 655°C
(v) Tensile strength - 0 95 to 1.57 tonnes/cm^2
(vi) Aluminium offers high resistance of corrosion because of the formation of oxide layer

(vii) Aluminium cannot be easily soldered. Soldering can be done by special technique
(viii) Aluminium joint offers high contact resistance

Aluminium is used to make following electrical parts :

(i) Rotor bar for electric machine (Three phase and single phase squirrel cage induction machine)
(ii) Bus bar
(iii) Overhead conductor.

Note

(i) Since the resistivity of aluminium is higher compared to copper, the wire has to have a thicker cross section to keep the I^2R losses low. Thus the winding occupies more space and the size of machine increases
(ii) Since density of aluminium is low compared to copper, aluminium wound machines have less weight.

High resistivity materials are used as resistance wires, heater filament, etc The resistivity range of high resistivity materials is between 10^{-6} to 10^{-1} ohm-m

These materials are also called resistance materials The common resistance materials with their characteristics and application are as below

Nichrome

It is an alloy of nickel and chromium. It is available in two forms.

(i) Nickel 80% plus chromium 20%
(ii) Nickel 61% plus chromium 15% plus iron 24%

It has following properties

(i) Melting point 1350°C to 1400°C
(ii) Normal working temperature 1000°C
(iii) Resistivity 108×10^{-8} ohm-m to 110×10^{-8} ohm-m
(iv) Temperature coefficient of resistance 0 00013/°C to 0 00017/°C at 20°C
(v) It can be drawn into thin wires and is mechanically strong

Application

It is used for making heating element of electric iron, electric ovens, room heater, electric furnace

Eureka

Eureka is copper - Nickle alloy
Composition - 40% Nickle plus 60% copper
It has following properties :

(i) The maximum permissible working temperature is about 500°C
(ii) It can be drawn into thin wire
(iii) Resistivity - 49×10^{-8} ohm-m
(iv) Melting point - 1300°C
(v) Temperature coefficient of resistance is 0 00001/°C at 20°C.

Applications

(i) It is used in starters and field regulator as a resistance wire
(ii) It is used in variable resistance
(iii) It is used in heater element and thermocouple, etc. at lower working temperature

High resistivity materials are also used as contactelement, i.e brushes ofelectric machines. Brush material Brush materials used in the field of electrical engineering are manufactured from graphite and other forms of carbon like coal, etc. The manufacturing process of electrical brush materials products consists of the following:

Grinding of the raw carbon materials, mixing of the powdered carbon with binding agent i e (coal tar) moulding of the requisite components and lastly baking the compound To increase the conductivity of carbon, different kind of additives like copper or bronze powder are mixed Physical propoi tion of some brush materials are given below :

Brush Materials	*Hardnesss Kg/mm2*	*Resistivity x10=6 ohm-m*
Electro graphite	3 to 50	6 to 25
Copper graphite	4 to 25	01 to 1 5
Graphite	8 to 22	8 to 28
Carbon graphite	18 to 42	40 to 57

Application

Brushes in electric machines and apparatus

Questions

(i) Name the materials which are used in making :
(a) Element of filament lamp
(b) Resistors for loading rheostat
(c) Element for electric heater
(d) Field regulator
(e) Electric arc furnace
(f) Brushes of DC motor

(ii) State the advantages and disadvantages of aluminium as compared to copper for use :
(a) As conductor in distribution of power
(b) As winding material in electric machine

(iii) Explain why conducting material like copper and aluminium are not used as heater element

(iv) Explain why carbon is used as brushes in electrical machine and variances and give other applications of carbon.

(v) Why is copper used mostly for winding work of electric machine?

(vi) Define resistivity

(vii) Differentiate between high and low resistivity materials

To Compare Copper and Aluminium as Conductor Material

Specific Objectives

(i) To differentiate between copper and aluminium
(ii) To identify copper as better conductor than aluminium
(iii) To differentiate between the quantity of copper and aluminium required for an application
(iv) To differentiate between the size of copper and aluminium required for an application
(v) To explain the suitability of copper and aluminium for an application

Related Information

Copper and aluminium are used as conductor materials As copper is a costly material, we are limiting its use as conducting material and replacing it by aluminium The comparison between the properties of copper and aluminium is as below .

Characteristics	*Copper*	*Aluminium*
Resistivity	1 72 to 1 78×10^{-8} ohm-m	2 8×10^{-8} ohm-m
Density	10 5	8 89
Mechanical strength	8 15 to 8 72 tons/ cm^2	0 95 to 1.57 tons/ cm^2
Cost	6	1

Both copper and aluminium are in common use as conductor wires and coils or solenoids We can identify the suitability of copper and aluminium by following tests

(i) Break Test Take wires of copper and aluminium of same size and length, fix it vertically at upper end and apply weight in steps at the lower end as shown in Fig 12.1

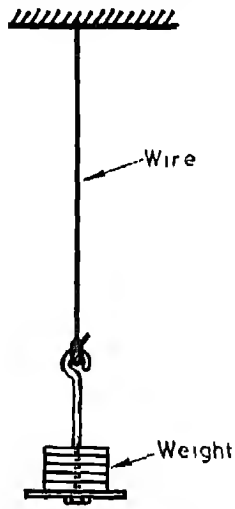


Fig. 12.1 Break Test

It can be seen that copper has more mechanical strength

(ii) Bend test Take wires of same gauge for copper and aluminium Fold and unfold it at one place, till it breaks. We can see that aluminium breaks very soon

(iii) Twist test . Take wire of same gauge for copper and aluminium and twist the two ends together till it breaks Count the twists

(iv) *Solenoid test* Make solenoids of copper and aluminium using same gauge and same number of turns of insulated wire Find resistance and weight of the solenoid and also measure the distance from which the solenoid can attract the iron particles The magnetic strength of the two solenoids can also be tested by attaching weight to the armature as shown in Fig 12 2 ·

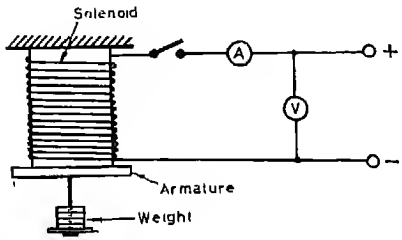


Fig. 12 2 Solenoid Test

Equipment and Materials

(i) Copper wire
(ii) Aluminium wire
(iii) Weights
(iv) Ammeter
(v) Voltmeter – 1
(vi) Battery 12V – 1
(vii) Single pole key – 1
(viii) Wire gauge – 1
(ix) Balance and weight box – 1

Procedure

(i) Take wires of copper and aluminium of same gauge and length Conduct break test on both wires Increase weight in steps till they break Note the weight
(ii) Take wires of copper and aluminium of same gauge and fold and unfold it, till it breaks and count the number of bendings
(iii) Take wires of copper and aluminium of same gauge Twist the two ends together till it breaks Count the number of twists
(iv) Take insulated wires of copper and aluminium of same gauge and make a solenoid of same number of turns
(v) Fix copper and aluminium solenoids vertically and apply same voltage to them Attach armatures and load them till the armature is pulled away. Note the weight
(vi) Measure resistance of both the solenoids by ammeter-voltmeter method or Ohmmeter
(vii) Measure the weight of both the solenoids

Observations

S No	*Tests*	*Copper*	*Aluminium*
(i)	Break test		
(ii)	Bend test		
(iii)	Twist test		
(iv)	Magnetic strength test		
(v)	Resistance		
(vi)	Weight		

Conclusion

From the experiment, it is observed that copper is better conductor material than aluminium Aluminium has very low breaking strength, bending strength, twisting strength and higher resistivity. Due to low mechanical strength, aluminium is not suitable for winding of rotating machines

Precautions

(i) Copper and aluminium wires should be taken of same gauge.
(ii) The solenoids must be of same gauge of wire and same number of turns
(iii) The voltage applied to the solenoids must be equal and of same value to limit the current

(iv) While weighing, the weight should be increased in steps

Questions

(i) Why is copper better conductor material than aluminium ?
(ii) Why is copper replaced by aluminium ?
(iii) Why is aluminium not in use for winding of rotating machines ?
(iv) How copper differs in weight and cost as compared to aluminium ?
(v) Why is aluminium not used as flexible wire?
(vi) Why is copper solenoid having higher magnetic strength than aluminium solenoid ?

ACTIVITY 13

To Study Insulating Materials

Specific Objectives

(i) To identify insulating materials.
(ii) To explain properties and application of insulating materials

Related Information

Insulating materials are used in electrical machines They are applied as

(i) Slot insulation
(ii) Wedge
(iii) Insulated tape
(iv) Enamels and insulating varnishes
(v) Sleeve
(vi) Cotton tape

Impregnated Paper/Leatheroid Paper

These papers are used as slot insulation in electrical machine It has following properties

(i) Electrical strength - 16 to 20 KV/mm
(ii) Resistivity - 10^{13} to 10^{15} Ohm - cm
(iii) Working temperature - 105°C.

Plastic Coated Paper

These papers are used for slot insulation and also to insulate between coil to coil. It has following properties .

(i) Electrical strength - 30 to 50 KV/mm
(ii) Resistivity - 10^{12} to 10^{16} Ohm - cm
(iii) Working temperature - 90°C.

Empire Cloth

These are used for slot insulation, insulated sleeves, tapes and liners, etc It has following properties

(i) Electrical strength 15 KV/mm
(ii) Resistivity - 10^{9} to 10^{-14} Ohm - cm
(iii) Working temperature - 150°C
(iv) Moisture absorption is less
(v) Due to varnish its electrical and mechanical strength become more

Wood

This is light in weight It is used for low voltage installation and slot wedge in electrical machines After seasoning and varnishing of wood, it becomes good insulator Its properties are given below

(i) Electric strength – 2 to 6 KV/mm
(ii) Resistivity – 4×10^{7} Ohm-cm
(iii) It has poor mechanical strength.

Impregnated Fibrous Boards

This fibrous board is used as slot wedge in electrical machines It has following properties:

(i) Electrical strength 16 to 40 KV/mm
(ii) Working temperature 130°C
(iii) It has good mechanical strength
(iv) Low dielectric losses

Enamels

It is extensively used in coating of winding wire of low rated motor and various types of instruments, etc. The maximum thickness of enamel coating is of the order of 0 05 mm. Such thin coating gives good space factor.

Enamels are stable to high temperature i e 180°C to 200°C.

Varnishes

Varnish is a liquid, usually a solution of resinous matter in an oil or a volatile liquid for applying to a surface Initially it dries either by evaporation or by heating resulting in a hard shining coating which is resistant to air and water. It has following properties

(i) Improving insulating properties of insulation material.
(ii) Increasing mechanical strength of insulator
(iii) Reducing the effect of oxidation
(iv) Protecting from atmospheric corrosion.
(v) Giving protection against moisture etc
(vi) Giving a fire retarding finish
(vii) Increasing surface resistance

Sleeve

The size of sleeves depends upon the thickness (SWG) of winding wire and connecting wire. Sleeve materials are empire cloth, impregnated asbestos, fibre glass, cotton and silk The size of sleeves are 1mm to 10mm in diameter and 1 metre length For high working temperature fibre glass sleeving are also used

Cotton Tape

These tapes are used in winding insulation The size of cotton tape is available in market in the form of roll 1/2" 3/4" 1" width

Equipment and Materials

(i) Leatheroid paper
(ii) Plastic coated paper
(iii) Empire cloth
(iv) Insulated tape
(v) Empire tape
(vi) Wedge (bamboo)
(vii) Sleeve
(viii) Cotton tape
(ix) Enamels and insulating varnish
(x) Fibre wedge
(xi) Display board

Procedure

(i) Identify the materials by visual inspection with the help of display board
(ii) Identify the insulating materials by manual inspection

Observations

S No	*Material*	*Visual finding*	*Manual finding*	*Specification*
(i)				
(ii)				
(iii)				
(iv)				
(v)				
(vi)				

Questions

(i) How can you identify different insulating materials by visual finding ?
(ii) How can you identify different insulating materials by manual finding ?
(iii) What are the materials used in slot insulation ?
(iv) What are the properties of insulated varnish ?
(v) What is the working temperature of given insulated materials,
  (a) Leatheroid paper
  (b) Empire cloth
  (c) Plastic coated paper
  (d) Fibre wedge
  (e) Enamels
(vi) Where are the sleeves used in machine winding and why ?
(vii) What are the properties of enamels ?

To Distinguish between Conductor, Resistance, Insulator and Semi-Conductor Materials

Specific Objectives

(i) To identify conductors, resistors, insulators and semi-conductors

(ii) To explain the difference between conductor, resistance, insulator and semi-conductor

Related Information

Materials used to conduct electric current or to resist electric current are of four types, namely (i) conductors (ii) resistance (iii) insulator and (iv) semi-conductor materials Depending on their resistivity, they are having their specific field of applications

Conductor materials are those which are used to conduct current with least resistance path, such materials have least resistivity We call these materials as low resistivity materials The resistivity range of such materials are in between 10^{-8} Ohm-m and 10^{-7} Ohm-m They are having 1 to 3 in their valency shell. Copper and aluminium are commonly used conductor materials having resistivity 1.72×10^{-8} Ohm-m and 2.87×10^{-8} Ohm-m respectively

Resistance materials are those which offer resistance to current flow through them. They are high resistivity materials. The resistivity range of such materials is between 10^{-6} Ohm-m to 10^{-3} Ohm-m Resistance materials in common use are the alloys of conductor materials Nichrome (80% Ni, 20%Cr) and Eureka (60% cu, 40% Ni) are commonly used resistance materials having resistivity of 1.1×10^{-6} ohm-m and 0.91×10^{-6} ohm-m, respectively

Insulator materials do not allow the flow of current through them. They have resistivity that does allow current to pass through them The resistivity is between 10^{6} ohm-m to 10^{18} ohm-m They have 5 to 8 electrons in their valency shell Mica, PVC, rubber, etc are the examples of insulating materials

Semi-conductor materials are neither good conductors nor pure insulators They have resistivity between 10^{-3} ohm-m to 10^{6} ohm-m They have 4 electrons in their valency shell Silicon, Germanium, selenium, copper oxide, etc are the examples of semi-conductor materials

The conductor, resistance insulating and semi-conductor materials are distinguished by observing the value of current flowing through these materials having same length and same area of cross-section They can be identified by measuring resistivity We can also identify and distinguish materials by visual inspection and resistance measurement using ohmmeter

Equipment and Materials

(i) Copper and aluminium wires

(ii) Nichrome and Eureka wires

(iii) Cotton, silk, rubber, PVC, mica, bakelite, ebonite, marble, asbestos, fibre glass, leatheroid paper, empire cloth, presspan paper, plastic coated paper

(iv) Silicon, Germanium and selenium

(v) Ohmmeter

(vi) Display boards for conductor, resistance, semi-conductor and insulating materials

Procedure

(i) Identify copper, aluminium, nichrome and Eureka by visual and manual inspections and also by measurement of resistance using ohmmeter

Tabular Record of Observation

S No	*Material*	*Colour*	*Specific Feature*	*Reading of Ohmmeter*
(i)	Copper			
(ii)	Aluminium			
(iii)				
(iv)				

(ii) Identify various insulating materials by visual and manual inspections with the help of the display board for insulating materials Connect insulating materials between the terminals of the ohmmeter and observe the reading

(iii) Identify various semi-conductor materials by visual and manual inspections with the help of display board for semi-conductor materials Put the semi-conductor material between the terminals of the ohmmeter and observe the reading

Questions

(i) How will you distinguish between a conductor and a resistance ?

(ii) How a semi-conductor differs with an insulator ?

(iii) What is the basic difference between a conductor, semi-conductor and insulator ?

(iv) How can you differentiate between various insulating materials ?

(v) How can we identify between Mica and PVC; Bakelite and Ebonite and Leatheroid paper and presspan paper ?

To Test Dielectric Strength of Insulating Materials and Insulating Oil

Specific Objectives

(i) To understand the term dielectric strength, dielectric constant and the break down voltage.
(ii) To acquire skill in testing dielectric strength of insulating material and insulating oil.
(iii) To acquire knowledge of dielectric strength for different insulating materials

Related Information

Dielectric Strength

All apparatus are designed to a defined range of voltage. If the operating voltage is increased, break down in the insulator occurs, thus spoiling insulation property permanently in solid insulating materials The property which attributes to such type of break down is called the dielectric strength.

Dielectric strength of an insulating material is the maximum potential gradient that the material can withstand without rupture This value is expressed in volts or Kilovolts per unit thickness of the insulating material. This value is greatly affected by its working conditions. Therefore for such information the condition under which the tests are conducted must be specified Use of high dielectric strength results in reduction to the size of the apparatus.

Dielectric Constant

Every insulating material has got the basic property of storing charge (Q) when a voltage (V) is applied across it The charge is proportional to the voltage applied, Q=CV

C' is the capacity across which the voltage is applied. Capacity is different for different insulating material. The property of insulating materials that causes the difference in the value of capacity, under physical dimensions remaining same, is called the"dielectric constant"

Break down Voltage

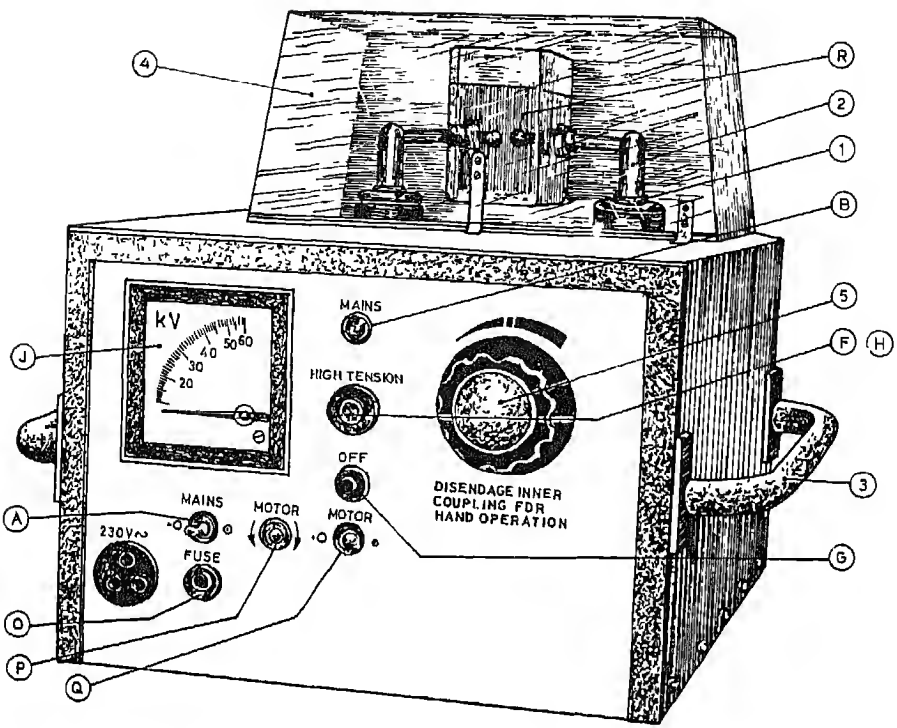
The voltage of which the permanent loss of insulating properties occurs is called the break down voltage

The dielectric strength of a solid insulator and liquid insulator is tested by using a Oil and Solid Insulator Testing Set.

An insulator testing set is shown in the Fig 15.1.

The test is carried out in a suitable vessel (test cell) having 55 × 90 × 100mm internal dimensions The electrode polished spheres of 12 7-13mm diameter made of brass are arranged horizontally on common axis 40mm above the bottom of the cell

The insulator to be tested for dielectric strength is kept between the 4mm air gap of the electrodes Then the voltage in steps is increased by variable auto-transformer which controls the primary voltage of the H.T transformer Secondary side of H.T. transformer is connected to the electrodes The voltage is increased till the spark occurs between the rods This flash over voltage read on the voltmeter mounted on the set is dielectric strength of



A-Main switch B-Mains indicating lamp FH-Push button on lamp pH T. G-Push button Off
J-Voltmeter O-Fuse P-Motor reversing switch Q-Motor stop switch R-Electrodes
1-Bakelite disc 2-Electrodes, 3-Handles 4-Acrylic cover ; 5-Variac knob
C-Voltage regulator D-Limit switch-zero end E-Tripping relay F-Push button On

Fig. 15.1 Oil and solid Insulation Tester

the insulator kept for test.

Equipment and Materials

(i) Insulating materials (Mica, Rubber and Porcelain)
(ii) Insulating oil.
(iii) Insulation test set

Procedure

(A) For Solid Insulators

(i) Clean the dust and dust of the solid material to be tested
(ii) Adjust the air gap of the test set electrodes between 2.5mm to 4mm
(iii) The insulator to be tested is placed in the gap between the two electrodes
(iv) Increase the voltage from zero at a rate of 1 kv /sec, by means of the motorised voltage regulator, till the arc is between the two electrodes
(v) Read the flash over voltage on the indicator dial which will be the dielectric strength of the solid material.

(vi) Take two more readings for same insulator (solid) and tabulate in the tabular column

(vii) Repeat the test for the other solid materials also

(B) For Liquid Insulation (Insulating Oil)

(i) Make the test cell electrodes of oil test set clean and free from dust

(ii) Rinse test cell and electrodes with oil under test to remove the moisture

(iii) Pour the oil to be tested slowly into the test cell till the oil is '10'mm above the electrodes

(iv) Stir the oil for air bubbles to escape

(v) Wait for five minutes till the air bubble escape

(vi) Close the test cell.

(vii) Start applying voltage, it should be raised from low value (not above 15 kv) to 30 kv at a uniform rate in 10–15 second-steps at a constant rate of 2 kv/sec.

(viii) The voltage is increased till the spark between the electrodes occurs

(ix) The flash over voltage is read on the voltmeter mounted on the set.

The reading shows the dielectric strength of the test oil

Observations

S.No.	*Innsulating material*	*Dielectric strength*
(i)	Mica	
(ii)	Rubber	
(iii)	Porcelain	
(iv)	Transformer oil	

Precautions

(i) Sample of oil should be withdrawn from transformers when the oil is warm

(ii) Sampling cock should be rinsed, before the oil is withdrawn for sampling

(iii) Sampling bottles should be thoroughly rinsed with the oil to be tested before filling the bottles The bottles should be rinsed with clean oil after the test

(iv) The samples brought from outside should not be exposed to air till it has reached the temperature of the room.

(v) Voltage should be raised in steps (10-15 seconds) from low value (not above 15kv) to 30 kv at a constant rate of 2kv/sec

Questions

(i) What is dielectric strength ?

(ii) Why is dielectric strength of an insulator to be tested ?

(iii) Why sampling cock should be rinsed before oil is withdrawn ?

(iv) Why the voltage is raised in steps ?

(v) What is flash over voltage ?

To Practise the Use of Insulating Sheets, Tapes, Sleeves and Varnishes

Specific Objectives

(i) To identify common insulating materials used in electrical machine winding.
(ii) To identify common insulating materials used as slot insulation, tapes and sleeves for joint insulation and insulating varnishes for impregnation
(iii) To use insulating sheets, tapes, sleeves and varnishes in winding of a machine

Related Information

Various insulating materials are used in winding of an electrical machine at various situations in sheet, tape and sleeve forms and also for impregnation

Insulating sheets are commonly used as slot insulation or body insulation The materials normally in use for such purposes are leatheroid paper, presspan paper, plastic coated paper, etc., The insulation, between the core and winding, insulates the winding coil from the body of the machine Fibre boards are also used as wedge in slots

To insulate coil from coil and their joints, tapes are used The commonly used tape materials are cotton, empire cloth, PVC sheets, etc

To insulate joints from winding and other joints, sleeves of different numbers are used The number of sleeve is based on the SWG of the conductor over which the sleeve is to be placed. The commonly used sleeve materials are empire cloth, cotton and silk, PVC, asbestos, fibre glass, etc

Impregnating varnishes are used to impregnate the winding in order to increase dielectric strength, heat conductivity, resistance to moisture absorption and mechanical properties of the insulation provided in the winding Such insulating varnishes are available in the market in various trade names After applying such varnishes in the winding, baking is required, which is done by heating the winding to dry

To find that the machine is properly insulated, it is tested for insulation resistance with the help of an insulation resistance tester or megger Insulation resistance is determined between winding and winding and also between winding and body or the earth. The insulation resistance is determined by megger in megaohms by putting the test points between the test terminals of megger, as shown in Fig 17 1 for insulation resistance between winding and the body or each

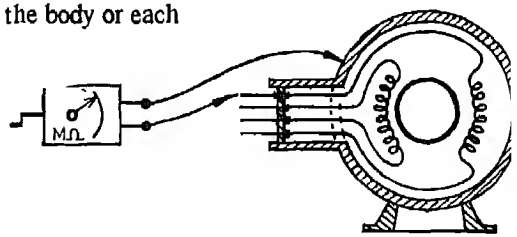


Fig. 16.1 Insulation resistance test by megger

Equipment and Materials

(i) Insulating sheets, tapes sleeves and impregnating varnish
(ii) Motor stator with winding
(iii) Megger
(iv) Motor stator without winding
(v) Measuring tape

(vi) Scissors

(vii) Display board for insulating materials

Procedure

(i) Identify insulating materials with the help of display board

(ii) Measure the length of stator slot and also the size of the slot and mark the size on the insulating sheet by increasing about one centimeter in every side and cut it to size with the help of the scissors

(iii) Put the cut sheet in the slot and observe that it should be projected at both sides of the slot lengths and its width should be such that an overlap can be made at the slot

(iv) Practise for applying tape over a coil and also over an open joint

(v) Prastise for selection of sleeve - size and put it at the joints and conductors

(vi) Prastise for impregnating a coil with impregnating varnish and baking it.

(vii) Measure insulation resistance of the stator winding with the help of megger

Observations

S.No	*Test points*	*Reading of Megger*
(i)	Between winding and winding	
(ii)	Between winding and earth	

Precautions

(i) Winding should be properly backed before measuring its insulation resistance

(ii) Tape should be applied with sufficient overlap and upto sufficient distance

(iii) Sleeves should have sufficient length for overlap.

Questions

(i) Explain how can the various insulating materials be identified?

(ii) Explain how can we cut the insulation sheet as per the size of a slot?

(iii) What precautions should be taken to cut the length of a sleeve and why?

(iv) How can the insulation resistance of a stator winding can be measured?

To Study Non-Magnetic, Soft-Magnetic and Hard-Magnetic Materials

Specific Objectives

(i) To identify non-magnetic and magnetic materials
(ii) To differentiate between soft and hard magnetic materials
(iii) To identify soft and hard magnetic material

Related Information

As per the magnetic properties of materials, we can classify the materials into three classes, namely

(i) Non-magnetic materials
(ii) Soft-magnetic materials, and
(iii) Hard-magnetic materials

This classification is mainly based on quantity of magnetisation and characteristics of retaining magnetisation

Non-magnetic materials are those materials, which either get no magnetisation or a negligible magnetisation even under strong magnetising force Such materials are not attached towards a magnetic field and are not useful as magnetic material These materials can be identified simply with the help of a permanent magnet. Magnetic materials are attracted by permanent magnet but -non-magnetic materials are not attracted. Copper, aluminium, wood etc are the examples of non-magnetic materials

The magnetic materials can be classified into two groups, namely (i) soft-magnetic materials and (ii) hard magnetic materials These are differentiated below

Soft magnetic materials get sufficient magnetisation under magnetising force but they do not retain its magnetisation for a very long time. Such a magnetic material is known as soft magnetic material Mild steel and silicon steel are the examples of such materials These magnetic materials are used as core material for electromagnets.

Hard magnetic materials are those which get sufficient magnetisation, under magnetising force and retain the magnetisation for a very long time Tungsten steel, ALNICO, etc. are the examples of such materials These magnetic materials are used for making permanent magnet

The magnetic and non-magnetic materials can be identified with the help of a permanent magnet as illustrated in Fig 17 1

The soft and hard magnetic materials can be identified by magnetising the materials and get-

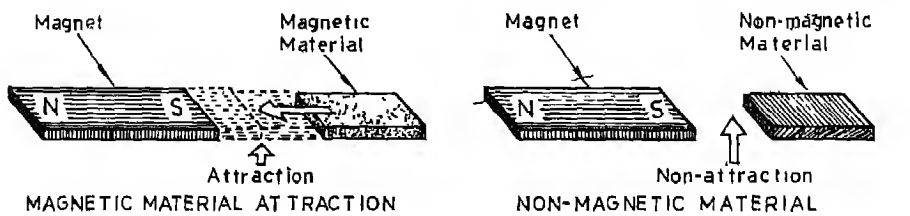


Fig. 17.1 Identification of magnetic and non-magnetic materials

ting their hysteresis loop or B-H loop as shown in Fig 17 2

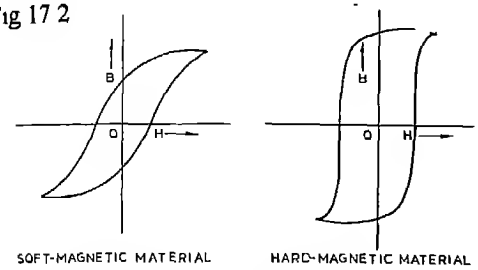


Fig 17.2 B H loop of magnetic materials

The soft and hard magnetic materials can also be identified by simply magnetising and demagnetising the magnetic material with the help of a magnetising coil as shown in Fig 17 3

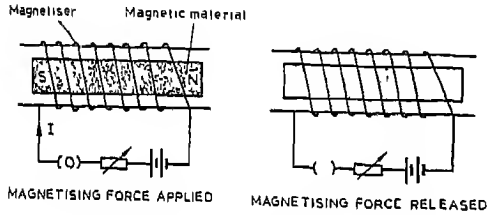


Fig 17.3 Magnetisation of magnetic materials

In case of soft-magnetic material, the materials get magnetised when a magnetising force is applied, but when the magnetisting force is released it retains only a small magnetisation for a short period In case of hard magnetic materials, the material gets magnetised and it retains magnetisation even after the magnetising force is released

Equipment and Materials

(i) Non-magnetic, soft magnetic and hard-magnetic materials
(ii) Permanent magnet
(iii) Magnetiser

Procedure

(i) Put test material near the permanent magnet and observe, whether it is attracted by the magnet or not.
(ii) Put the magnetic material inside the magnetiser and observe its magnetisation.
(iii) Take out the magnetised magnetic material, wait for some time and observe its magnetisation

Observations

S No.	*Test material*	*Response to permanent magnet*	*Response to magnetiser*	*After demagnetisation*	*Remarks*
(i)					
(ii)					
(iii)					
(iv)					

Precautions

(i) Magnetiser should be of sufficient current rating having ON/OFF and current adjustment arrangements

(ii) Material should be put in the magnetiser or taken out from magnetiser in OFF position.

Questions

(i) Differentiate between magnetic and nonmagnetic materials.

(ii) How can you identify magnetic and non-magnetic materials ?

(iii) What is difference between soft and hard magnetic materials ?

(iv) How can you identify soft and hard magnetic materials ?

(v) If you are given a material, explain how can you say about its class in reference to magnetic materials ?

To Study Constructional Materials of Electrical Machines and their Uses

Specific Objectives

(i) To acquaint with constructional materials used in electrical machines
(ii) To familiarise with the use of different constructional materials in electrical machines
(iii) To identify various constructional materials used in electrical machines
(iv) To explain general properties of constructional materials used in electrical machines

Related Information

Ferrous, non-ferrous and non-metallic materials are used as constructional material in various electrical machines. These materials are either used as yoke or as mechanical part or as case, blade, etc The constructional materials in common use are as below

Cast Iron

It is a ferrous material made of pig iron having 2% to 4 5% carbon It is having high compressive strength but a little tensile strength It is a brittle metal and cannot be tempered Welding and riveting is also not possible in it Its melting point is between 1050°C 1125°C. Various machine parts like yoke, brush gear, pulley, end covers, cooling fins, etc are made of cast iron by casing the parts in their molds It is a magnetic material.

Wrought Iron

It is a ferrous material having maximum upto 0 25% carbon in the iron It is having fibres construction It is a ductile and malleable material Its melting point is about 1535°C Forging, welding and cutting is possible but hardening and tempering is not possible It can be bended to any shape It is used for construction of pipes and galvenised sheets to be used in machine parts.

Mild Steel

It is a ferrous material having upto 0 35% carbon in it It is a flexible, ductile and malleable iron material Welding, machining and tempering is possible in this material It is a magnetic material. It gets rusted quickly. It can be bended in any shape. Mild steel is available in market in the forms of rod, angle, channel, sheets, etc used as yoke of static machines, body and tank construction, blade construction, shaft construction etc.

Aluminium Alloy

It is a non-ferrous metal having small mechanical strength. Adding small quantity of copper, zinc, nickle or magnetism improves its hardness and strength. It is a non-magnetic material. Machining is possible in the material Aluminium alloy is also used in small machines as body part and blades

Plastics

It is a non-metallic and non-magnetic material. Now a days plastics are available in sufficient mechanical strength and are in use in small

machines as body parts and blades, etc.

Brass

It is a non-ferrous metal and is the alloy of copper and zinc It is a non-magnetic material but good conductor to electric current Machining, welding, soldering, brazing, etc is possible in brass It is used for construction of such parts of electrical machines which also carry current through it like brush holders, sliprings, etc

Equipment and Materials

(i) Cast iron, cast steel, mild steel, brass, aluminium and plastic
(ii) Permanent magnet
(iii) Hammer
(iv) Ohmmeter
(v) Machine parts related to constructional materials
(vi) Display board for constructional materials

Procedure

(i) Physically inspect the materials to differentiate and identify them, with the help of display board
(ii) Note the effect of hammering
(iii) Detect the electrical conductivity with the help of ohmmeter.
(iv) Observe the magnetic quality by attribute of the materials with the help of a permanent magnet

Observations

S No	*Material*	*Observations by observations*	*Observations by handling*	*Hammering effect*	*Magnetic effect*	*Electrical conductivity*
(i)						
(ii)						
(iii)						
(iv)						

Precautions

(i) Handle machine parts carefully.
(ii) Electrical and magnetic properties of the materials must be observed carefully
(iii) Material and its use must be coordinated with display board and actual part of the machine

Questions

(i) Differentiate between metallic and non-metallic materials and give their examples.
(ii) How can we differentiate between cast iron and mild steel ?
(iii) List the parts made of brass in an electric machine
(iv) Why is yoke of a machine made of magnetic materials only ?
(v) When can we make the body of a machine from plastic or aluminium alloy ?

To Study Fuse and Fuse Materials

Specific Objectives

(i) To explain fuse characteristics.
(ii) To identify various types of fuses
(iii) To identify various fuse materials.
(iv) To explain properties and application of common fuse materials.
(v) To specify the application of common fuses

Related Information

A fuse is a protective device, which consists of a thin wire or strip. This wire is placed in series with the circuit for protection Current flows in the circuit through it When this current is too large, the temperature of wire will increase till the wire melts for breaking the circuit

Fusing current

This is the minimum value of current that will blow the fuse in a circuit

Current rating

This is the maximum current that a fuse will carry for infinite time without deterioration of the fuse element.

Fusing factor

This is the ratio of the fusing current to the current rating of fuse, i e

$$\text{fusing factor} = \frac{\text{Fusing current}}{\text{Current rating of fuse}}$$

The value of fusing factor is always greater than unity.

The time-current characteristics of a fuse material is shown in Fig 19.1 The melting of fuse element depends upon heating effect of electric current It is directly proportional to I^2Rt
Where I = Fusing current in A
R = Resistance of fuse wire in ohms
t = Fusing time in seconds

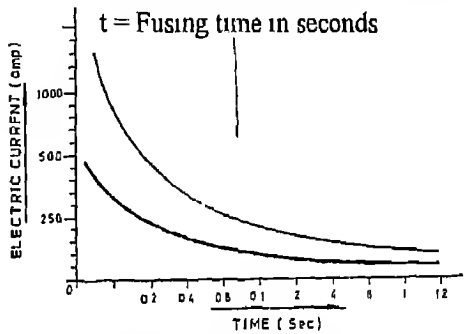


Fig 19 1 Characteristic of fuse material

Types of Fuses

(i) Low voltage tube type fuse is shown in Fig 19 2

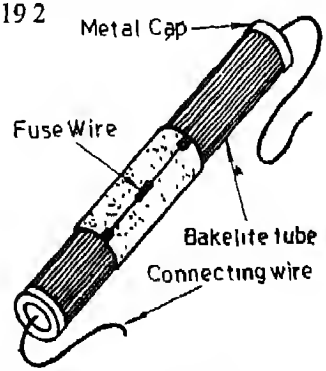


Fig. 19.2 Tube type fuse

(ii) Rewireable or kit kat fuse - (300 Amp, 400V) is shown in Fig.19.3.

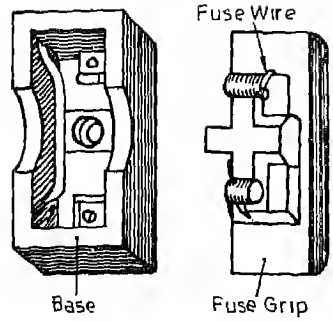


Fig 19.3 Kit - Kat fuse

(iii) Cartridge type fuse or HRC fuse (15-33000 Amp) is shown in Fig. 19 4

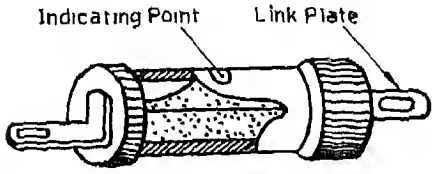


Fig. 19.4 HRC fuse

(iv) Busbar fuse (15 amp to 33000 Amp) is shown in Fig 19.5

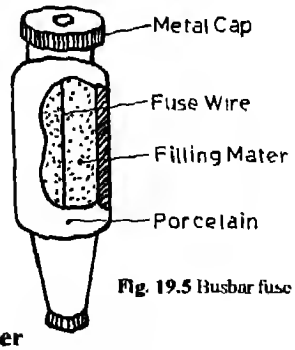


Fig. 19.5 Busbar fuse

Silver

Due to specific property silver is used as fuse wire

It is not used as a general fuse for high cost Properties of silver are given below

(i) It is soft and tensile metal.

(ii) The power loss is very low because it has very small value of specific resistance i e 1 64 × 10^{-8} ohm-m.

(iii) It has low melting point 960 8°C

(iv) It has low liner expansion coefficient 19 2 × 10^{-6}/°C

(v) Temperature coefficient of resistance = 0 0036/°C at 20°C

Applications

(i) It is used in low rating HRC fuses

(ii) It is used in costlier apparatus as a fuse wire

Tin

It is very soft alloy metal having low melting point It is used as fuse wire. Properties of tin are given below

(i) Melting point - 231 89°C

(ii) Specific resistance - 11 3 × 10^{-8} Ohm-m

(iii) Specific heat 0 055 cal/gm/°C

(iv) Linear expansion coefficient 25 × 10^{-6}/°C

(v) Temperature coefficient of resistance = 0 0042/°C

It is not used as a fuse wire in its pure form because tin is very soft material

Lead

Properties of lead are given below :

(i) Melting point 327 43°C

(ii) Specific resistance 21 × 10^{-8} Ohm-m

(iii) Specific heat 0 031 cal/gm/°C

(iv) Linear expansion coefficient - 0.0041/°C

(v) It is non-corrosive metal

(vi) It has low melting point

It is not used as a fuse wire in its pure form because lead is very soft material

Lead-Tin Alloy

It is an alloy of 37% lead and 63% tin. It is also known as electric alloy. It has higher resistivity and have high resistance for oxidization. It is very suitable to use in a 10 ampere rating circuit.

Copper

It is free from corrosion It is used as fuse wire Due to high tensile strength it is used in fine wires Properties of copper are as follows

(i) Melting point - 1083°C
(ii) Linear expansion coefficient - $16\ 7\times10^{-6}$/°C
(iii) Specific heat 0 093 cal/gm/°C
(iv) Resistivity - $1\ 72 \times 10^{-8}$ Ohm-m

Since copper has high melting point, it is not used below 10 Amp, as a fuse materials It is used generally as rewireable fuse

Properties of Good Fuse Materials

(i) It has low melting point, because at low temperature it should melt for breaking the circuit and interrupting the supply
(ii) Low resistivity because thin wires can be used which will give less metal vapour after melting of the wire Arc gives lower conductivity and thus makes quenching of the arc easier
(iii) Low conductivity of the metal vapour
(iv) Lower power loss in fuse wire
(v) Lower specific heat
(vi) Free from oxidation and corrosion
(vii) Low coefficient of expansion
(viii) High thermal conductivity so that heat dissipation is good

Equipment and Materials

(i) Display board for fuse materials
(ii) Display board for fuses
(iii) Copper wire
(iv) Copper-tin alloy
(v) Lead-tin alloy
(vi) Silver wire
(vii) Rewireable fuse unit
(viii) Ohm meter/series test lamp
(ix) A C supply line

Procedure

(i) Identify various fuse materials with the help of display board
(ii) Identify various fuses with the help of display board
(iii) Observe the method of fixing fuse element in different type of fuses.
(iv) Practise for connecting fuse element in a rewireable fuse
(v) Find continuity of circuit through fuse element with the help of ohmmeter/series test lamp

Observations

S No	*Fuse material/ Fuse unit*	*Inspection by observation*	*Inspection by handling*	*Specifications*
(i)				
(ii)				
(iii)				
(iv)				

Precautions

(i) The fuse element of HRC fuse should never be replaced
(ii) In rewireable fuse (kit-kat type fuse) the fuse element must be placed in its proper place

Questions

(i) What is the function of a fuse ?
(ii) Why is the melting point low in fuse materials ?
(iii) Why is not purely tin wire used as a fuse wire ?
(iv) What do you mean by fusing current?
(v) What do you mean by fusing time?
(vi) Which type of fuse is used in domestic purpose?
(vii) Which type of fuse is costly but most accurate?
(viii) Define fusing factor

ACTIVITY 20

To Study Soldering and Brazing Material and Fluxes

Specific Objectives

(i) To develop the concept of soldering and brazing as jointing processes.
(ii) To develop the knowledge of different jointing material and fluxes used in soldering and brazing

Related Information

Soldering is a process of obtaining a semi-permanent joint of metallic parts by applying a fusible alloy metal, termed as solder, in molten state between the base metals The parts to be joined are not brought to plastic state but the molten alloy, constituting the filler, merely holds the parts together by slight diffusion into the base metals Therefore the strength of the soldered joint is determined by the strength of the weaker filler metal

Materials used in soldering and brazing are solders, spelters, fluxes

Solder materials (filler alloys) are classified into hard solders and soft solders, on the basis of their melting temperature range Depending upon use there are a number of compositions Composition of soft solders are lead and tin, alloyed in varying proportion and has lower range of melting point (145 C to 450 C) Hand solders are alloys of silver and tin, which has maximum range of melting point (450°C to 1100°C)

Soft solders are available in the form of wires and sticks The wire may be cored or solid Cores are filled with flux These are used to join wires and small parts employed in electrical work and sheet metal work

Hard solders are available in the form of thin sheets, coils, sticks or granules Parts where welding is not practical but stronger joints are required are hard soldered

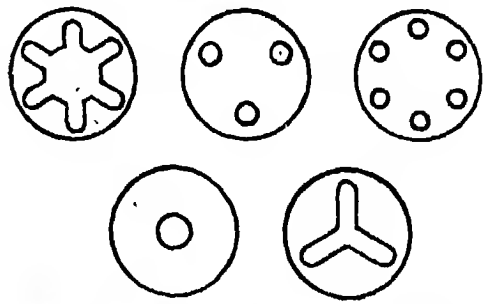


Fig. 20.1 Cross-sections of different Resin cored solder

Brazing is similar to hard soldering except that it employs filler metal which are copper-base alloys and commonly termed 'spelters' In most cases copper and zinc are alloyed in varying proportions to obtain a suitable spelter The melting temperature of spelters range from 1100°C and above

Soldering fluxes are of two types – non-corrosive and corrosive

Flux is a chemical agent which, when properly applied to metal being soldered/brazed will aid in 3 ways – (i) it will coat the surfaces of the joint to protect them from oxidation, (ii) it will dissolve any oxide that might have formed on the surface being joined, (iii) it will lower the surface tension of the moten alloy (solder/spelter) to allow it to flow more freely into the joint.

Fluxes are of large variety The choice of a flux depends on the material being soldered/

brazed Soldering fluxes are of two types (i) Non corrosive or organic and (ii) Corrosive. Non-corrosive fluxes leave residue which are non-corrosive, but corrosive fluxes are washed off after soldering

Borax in its amorphous or fused form is the basic constituent of brazing fluxes, which are mixtures compounded to obtain lower melting point than that of borax

Fluxes are generally of dry powder form or of paste form

Another material used for cleaning the surface is killed muriatic acid This is prepared by adding small scraps of zinc to hydrochloric acid till the acid fails to eat the zinc. This killed acid is zinc chloride It is used in raw state or with 50% alcohol depending upon the material being soldered.

Equipment and Materials

(i) Different solders (soft and hard) in different forms
(ii) Different forms of spelter
(iii) Different types of soldering and brazing fluxes
(iv) A magnifying glass

Observations

Procedure

(i) Take each type of soldering material and list them in the table giving specifications, properties, and uses
(ii) Take each type of spelters and list them in the table giving specifications, properties and uses.
(iii) Take different types of non-corrosive and corrosive fluxes for soldering and fluxes for brazing and list them in table (giving specifications, properties and uses)
(iv) Observe the cross section of core type solder wires with the help of a magnifying glass

Precautions

(i) Solder/spelter and fluxes are costly Do not waste them
(ii) Fluxes may be corrosive Therefore wash your hands well after handling them

Questions

(i) What is soldering ?
(ii) What is a solder ?
(iii) Distinguish between soft and hard solders
(iv) What kinds of solders are commonly used in electrical motor repair shop ?
(v) What is most important operation in sol-

Material observed	*Description/ composition*	*Form*	*Melting Point*	*Use*	*Remarks*
Solder (Soft) Solder (Hard) Spelter Soldering Fluxes Non-corosive Soldering Flux Corrosive Brazing Flux					

dering and why ?

(vi) What is a spelter ?

(vii) Give the composition and melting point of commonly used solders

(viii) Give the composition and melting point of commonly used spelter

(ix) Distinguish between soldering and brazing

(x) Why two metal pieces can not be soldered or brazed together successfully without the aid of flux ?

(xi) Enumerate the functions of a good flux

(xii) Enumerate the requirements of a good flux

(xiii) What is a killed acid and how is it prepared ?

(xiv) What kind of flux is best to use for soldering commutator wires and electrical connections ?

(xv) Why is it necessary to clean out the excess flux from a soldered/brazed joint ?

To Practise Soldering and Brazing

Specific Objectives

(i) To acquire the skill of soldering
(ii) To acquire the skill of brazing

Related Information

Soldering practice Soldering is a process of joining two identical metals together by a third filler soft metal of lower melting point, which is applied in molten state

It involves preparation of the surface to be soldered, i.e derusting and degreasing and covering with flux, and preparation of the joint Then the base metal is heated depending on its size, solder metal is melted and applied on the base metal with the help of hot soldering iron

The important factors which govern the selection of solder iron, solder material and flux material depend on the following .

(a) *Temperature* · Maximum temperature to which a joint can be raised without damaging the base material depends on the wattage of electric soldering iron or the size of the copper (non-electric soldering iron), and the type of solder
(b) *Thermal capacity and conductivity of the joint* · A large and heavy good conducting base material will need a soldering iron of higher wattage/size
(c) Required mechanical strength of the joint decides selection of soft solder/hard solder/ spelter composition.

If the solder iron is electrical type, it is heated by plugging it to line If it is non electrical type soldering copper, it is heated by blow-lamp or over a gas flame

The cleaning of soldered joint : When a soldered joint becomes cold and hard, the flux residue are removed Rosin is removed with a brush and a little alcohol If the flux has a water soluble salt suspended in grease, remove grease first using grease solvent and then a hot water wash to remove the salt.

Equipment and Materials

(i) Soldering iron
(ii) Cables/enamel wires of different sizes for joint
(iii) Solder
(iv) Soldering flux
(v) Sheets/plates for brazing practice
(vi) Spelter
(vii) Brazing flux
(viii) Pliers
(ix) Tong
(x) Blow lamp
(xi) Emery paper

Procedure

A. Soldering Practice

(i) Remove the insulation over the enamel wire by burning the enamel (in case of P V C wire remove the P V C coating carefully)
(ii) Clean the individual parts to be joined mechanically using emery paper.
(iii) Clean the soldering iron tip with emery paper.

(iv) Allow the soldering iron to heat up
(v) Clean the joint surface using killed acid or coat it well with commercially prepared flux
(vi) Apply the solder on the tip of the iron so that a layer of solder is deposited on it. Repeat this process if the bit of the iron is not holding the molten solder, till it holds.
(vii) Apply a coating of the solder on the cleaned surfaces of the wires to be joined. This is called 'Tinning'
(viii) Make the mechanical joint using pliers
(ix) Press the tinned parts with the hot soldering bit and apply solder, so that it flows and forms a loop over the points to be joined
(x) Remove the soldering iron while keeping the point intact and allow the joint to cool.
(xi) Clean the joint when it becomes hard

B. Brazing Practice

The procedure for brazing is same as soldering except that

(i) Heat both members or surfaces of the joint above the melting temperature of the spelter with the blow lamp or a blow torch
(ii) Cover the joint surfaces with flux before heating them
(iii) Hold the two parts to be joined firmly in relation to each other during both heating and cooling and do not move them until the alloy spelter is solid

Precautions

(i) Do not use soldering iron with dirty tip Clean the tip well before starting a new work.
(ii) Do not place the soldering iron near such components and equipment which can be affected by heat
(iii) Clean the joint surface otherwise weak joint will result or dry solder will result
(iv) Keep the tip of the iron on the joint portion only. Avoid touching adjoining portions which may get damaged due to heat
(v) Do not keep the solder and flux on the soldering iron for long time to avoid their decomposition
(vi) Use heat sinks where the gap between two joints are too small, otherwise excessive heat may damage them
(vii) Avoid the drops (flash) out of the solder and flux to fall on unwanted portions
(viii) Clean the joint area immediately after soldering to avoid corrosion due to excess flux
(ix) Blow-out the joint with compressed air to remove dust etc

Tabular Record

S No	*Sketch of Joint*	*Jointing Material (Specification)*	*Solder/ Spelter used*	*Flux used*	*Heating device used*
(i)					
(ii)					
(iii)					
(iv)					

Questions

(i) What is a soldering iron ?
(ii) How is a soldering iron heated. ?
(iii) How is soldering iron prepared for use ?
(iv) How is the surface of metal piece to be joined ?
(v) What is tinning ?
(vi) How to prevent solder from running away from the surface to be joined ?
(vii) Why is it important to clean and wash the surface soldered after it cools down ?
(viii) How grease based fluxes are washed off ?

Application, Care and Maintenance of Soldering Iron and Blow Lamp

Specific Objectives

(i) To select a suitable soldering iron for a specific job
(ii) To keep soldering iron and blow lamp in working order.
(iii) To carry out maintenance of soldering irons and blow lamps

Related Information

Soldering irons may be externally heated type with forged iron or copper bit, iron shank and wooden handle, or electrically heated type with electrical heating coil installed within its body itself

The externally heated forged bit are heated on coal fire, gas fire or with a blow lamp The bit shape may be according to job requirement– axe shaped bit for heavy work, cone shaped bit for general work and adjustable bits for specific work

The electrical soldering iron has a heating coil enclosed in electrically insulated chamber inside the barrel portion of the iron It has plug type or screw type tips of different size and shape The wattage of the heating coil generally available range from 12 to 125

The choice of soldering iron depends mainly on the temperature requirement in the soldering process and its bit shape depends on the shape of the work surface.

The blow lamp is infact a kerosene pressure stove with a horizontal (or inclined) burner The principal parts of a blow lamp are

(i) Safely rod (mild steel)
(ii) Tank (brass)
(iii) Heating cup (copper or brass)
(iv) Mixing duct (copper or brass)
(v) Flame tube (brass)
(vi) Mixing chamber (steel)
(vii) Nozzle (copper)
(viii) Air protection screen (copper)
(ix) Fuel control valve (brass)
(x) Fuel filling cap (brass)
(xi) Pump (steel) with leather washer

The flame of the lamp should be blue for generating maximum temperature

Equipment and Materials

(i) Forged iron soldering bit (different shapes)
(ii) Forged copper soldering bit (different shapes)
(iii) Electric soldering iron of different wattage
(iv) Blow lamp
(v) Spanner for opening the burner
(vi) Stove pin

Procedure

A Maintenance of Soldering Bit

(i) Clean the bit solder deposited on it by heating and wiping with a soft pad.
(ii) Check for the plug or screw holes in the bit for inserting tips which should fit tight in the bit.
(iii) Check the electric connections in electric soldering iron for loose connections

B. Maintenance of Blow Lamp

(i) Test the pump washer, pump plunger etc which should work smooth and pump air into the tank. Change the leather washer if it works loose.

(ii) Clean the nozzle hole with the needle provided for the purpose (stove pin) by pinning it If the hole is large or irregular, replace the nozzle

(iii) See that the tank is not more than 3/4 filled with kerosene

(iv) Close the control valve and filling cap and pump air in the tank Replace them if they are found loose.

(v) Check for leakage, if any, at the valve, and at the burner joint The kerosene should come out of the nozzle in a thin jet

(vi) Fill the heating cup with spirit, ignite, and allow the burner to heat up

(vii) Ignite the jet with a match stick and allow mixing chamber and flame tube to heat up

As soon as it takes up the required temperature the flame will become blue This is done by adjusting the valve

(viii) Pump until the flame becomes uniform. A properly maintained blow lamp will give a blue flame of uniform shape.

Precautions

A Soldering Iron

(i) Never use a file to clean the soldering iron bit

(ii) Disconnect the iron from electric point when not in use

(iii) Always keep the hot bit on a stand

(iv) Safeguard the bit from moisture, acid or alkali

(v) Never use over size bit in soldering.

B. Blow Lamp

(i) Never fill the tank more than $\frac{3}{4}$.

(ii) Use denatured spirit for heating flame tube. Heating it with spilled kerosene may choke the nozzle hole

(iii) Never over pump air

(iv) Keep the oil tank always in upright position

(v) Always pin the hole before lighting the flame

(vi) Never pin when the flame is on

Questions

(i) What are the uses of soldering iron?

(ii) On what factors selection of soldering iron depend ?

(iii) Sketch a forged iron bit

(iv) Sketch an electric soldering iron

(v) Where are blow lamps needed in soldering/ brazing ?

(vi) Why only $\frac{3}{4}$ portion of the lamp tank filled in ?

(vii) Why is oil tank kept in upright position ?

To Make Joints of Winding Wires, Conductors and Cables

Specific Objectives

(i) To study the common properties of joints
(ii) To study the types of joints according to use
(iii) To practise jointing of winding wire, conductors and cables

Related Information

It is often required to make joints in winding wires, conductor wires and cables for extension or termination or tapping The process of making such joints is known as jointing of conductors and cables. The joint made must have following properties .

(i) The joint should be mechanically strong
(ii) The joint should have 95% tensile strength
(iii) It should have 100% electrical continuity.
(iv) The joint should be soldered.
(v) The joint should be perfectly taped

Following are the type of joints in common use .

Simple Twist (Straight Joint)

It is used to increase the length of single solid wire

'T' Joint

It is used to tap the connection from the running horizontal line. It is also known as tap joint.

Terminal Joint

It is to terminate the conductor at the terminal point

Nowadays crimping tools are used for making cable joints They are either manual or kneumatic types. Different type of crimping tools are illustrated in Fig 23 1 1, 23 1 2, 23 1 3, 23 1 4 and 23.1 5 for crimping using different sizes of lug

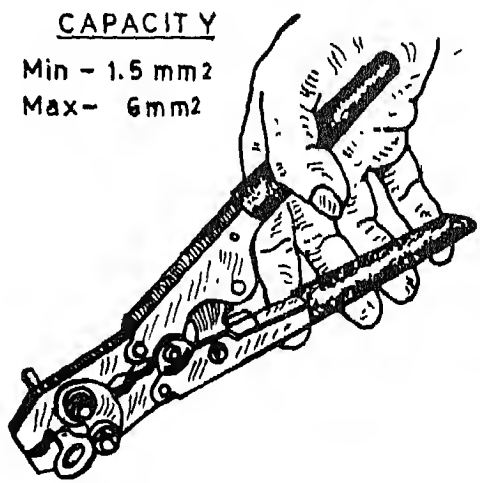


Fig. 23.1.1 Manual crimping tool

Equipment and Materials

(i) Material (winding wire, insulated conductor or cable)
(ii) Insulated pliers

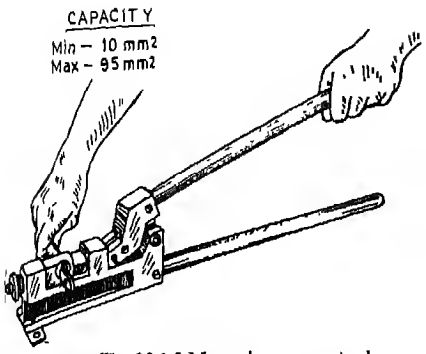


Fig 23.1.2 Manual crimping tool

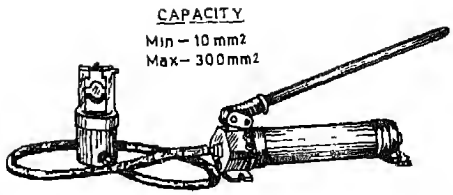


Fig. 23.1.4 Hand operated kneumatic crimping tool

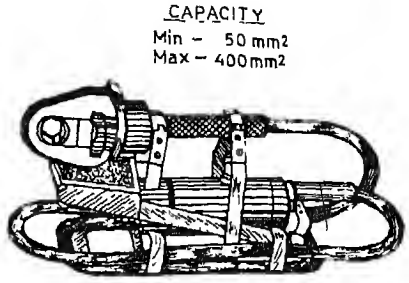


Fig 23.1.5 Foot operated kneumatic crimping tool

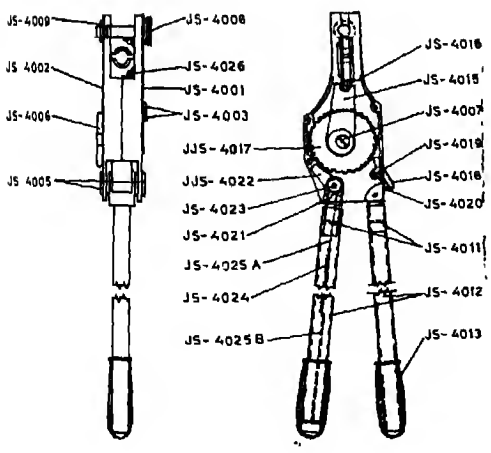


Fig. 23.1.3 Hand operated crimping tool

(iii) Side cutting pliers
(iv) Knife
(v) Sand paper
(vi) Sleeve/empire tape/cotton tape/insulating tape
(vii) Soldering iron
(viii) Solder/flux
(ix) Crimping tool.

Procedure

A. Straight Joint

(i) Remove insulation of the wire up to length of 7.5cm from one side as shown in Fig 23.2.
(ii) Wires are then to be placed in cross position about 2 5 cm from the insulation
(iii) Clean the bare portion of the wire with sand paper
(iv) The wires are then wrapped closely and tightly round each other in 6 to 8 turn

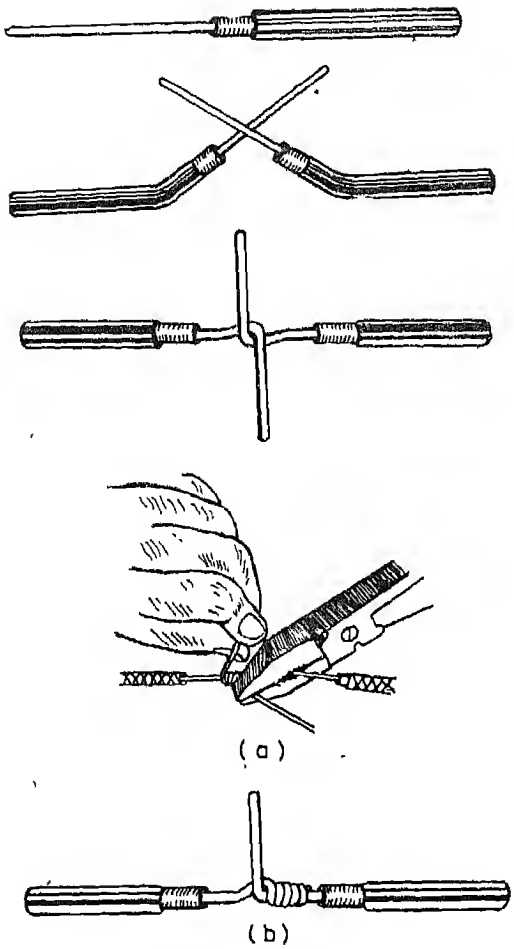


Fig 23.2 Straight joint

(v) Cut the remaining excess portion of the wire with the cutting pliers and all turns should be tightened.

(vi) The process is repeated with the other side and the joint is completed.

(vii) The joint should be soldered and taped with the help of soldering iron and insulating tape respectively

B T-Joint

(i) Take two horizontal and vertical length of wire 30cm and 20cm respectively.

(ii) Remove the insulation of straight (horizontal) length 4cm at the middle (centre) portion as shown in Fig. 23 3.

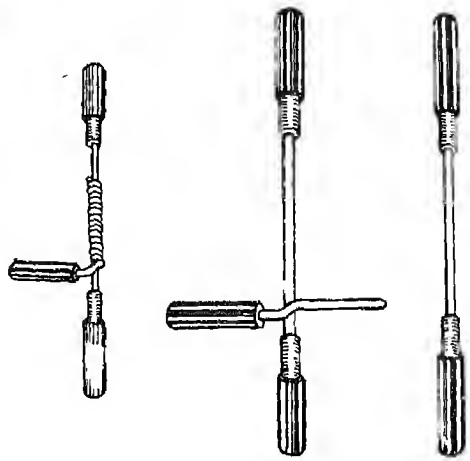


Fig. 23.3 T-joint

(iii) Remove the insulation of taping vertical length of about 7.5 cm at one end

(iv) Clean the base wires by sand paper.

(v) Hold both the (tap or vertical) wire at 90° to the running (horizontal) wire and make a neck turn to avoid slipping of joint

(vi) Wrap off the conductor closely and tightly 6 to 8 turn on the horizontal wire

(vii) Cut off the excess of conductor with the help of cutting pliers

(viii) Round off the conductor's end with the help of insulated pliers

(ix) The joint is soldered and insulated with tape

C. Terminal Joint

(i) Remove insulation of wire up to 6cm from one side

(ii) Clean the bare portion of the wire with sand paper.

(iii) Bend the conductor in the form of loop as

shown in Fig 23 4.

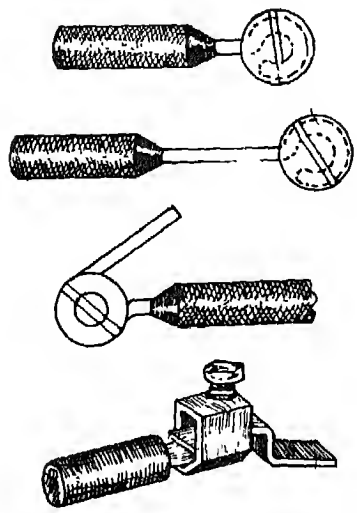


Fig. 23.4 Terminal joint

(iv) Cut the excess portion of the wire with cutting pliers.

(v) Tighten the loop with the help of nut screw etc

For thick wire, solder-less connection can be done as shown in Fig 23 5.

D. Cable Jointing

(i) Select right die-set for cable terminals end and cable

(ii) Fit the die-set in the tool by removing the die stopper Dies should be inserted in the slots of the tool.

(iii) After inserting the conductor in the lug, crimping operation can be started by moving the handle up and down till the two portions of the die set touch each other, thereby insuring perfect crimping.

(iv) Then remove the cable duly crimped with the terminal end, crimping joints are shown in Fig 23.5

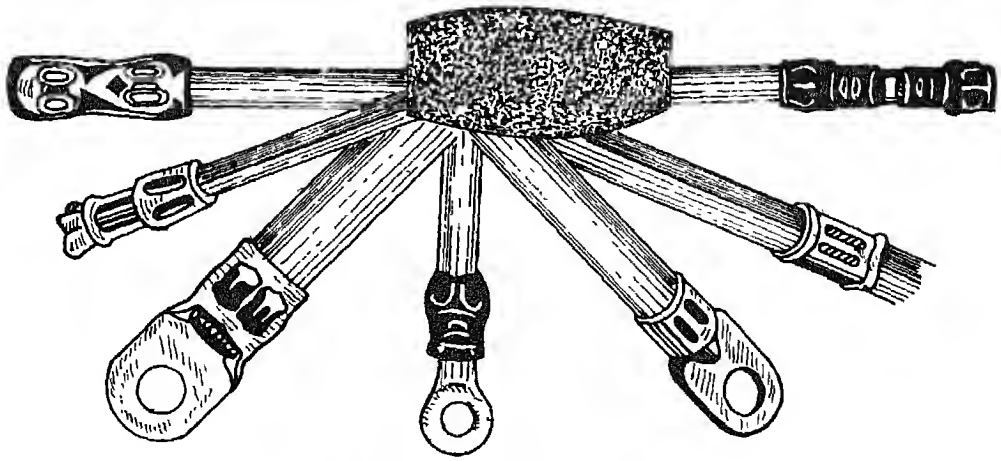


Fig. 23 5 Main switch, switch and fuse

Precautions

(i) For removing insulation, the knife should be kept in an angle and not at right angle
(ii) The free ends of wire should be cut off very carefully and cut down very close to the straight portion, so that it may not extend over the surface
(iii) Every strand of the conductor must be cleaned with sand paper
(iv) The joint should be perfect in mechanical strength
(v) Do not hammer the joint

Questions

(i) On which situation is 'T' joint performed ?
(ii) Which type of joint will be used in winding wire and connecting wires ?
(iii) What are the basic operations to be performed for making joints ?
(iv) What are the properties of a joint ?
(v) What are the operations to be performed in soldering? Why is joint soldered ?
(vi) What are the materials used for insulating the joints ?
(vii) What are the tools used for making joints ? State their use.

ACTIVITY 24

To Study Wiring Materials and Accessories

Specific Objectives

(i) To identify wiring materials and accessories
(ii) To develop knowledge about the application of wiring materials and accessories
(iii) To develop knowledge about the specification of materials and accessories

Related Information

To carry electrical power from supply mains to the appliances, electrical wires are layed through base materials with protection and control arrangements, such an electrical installation is known as wiring The wiring used in residential houses is called domestic wiring and the wiring used in industry is called industrial wiring The wiring used for light fan operations either in domestic purposes or industrial purposes is called light-fan wiring and the wiring used in both the cases for power applications is called power wiring The methods or system of wiring are listed as below

(i) Cleat wiring – for temporary purposes.
(ii) Wooden casing – capping wiring-out dated
(iii) Battern wiring – for light fan and domestic power wiring
(iv) Lead sheathed wiring - very specific
(v) Conduit wiring - for light fan and domestic and industrial wiring

The wiring materials used are

Battern

It is made of teak wood of 12 5 mm thickness and different widths It is specified as width × thickness It is base material for wiring gullies and roul plugs Gullies are made of teak wood and roul plugs are plastic plugs Both are used for fixing base materials on wall

Wiring Clips

Wiring clips are made of tin or aluminium They are specified in length and are used for fixing wires on battern

Nails

Iron nails or brass nails are specified in length and are used for fixing wiring clips on battern

Round Blocks

It is made of wood of dia 100mm and thickness 20mm Double round blocks are of thickness 40mm

Wooden Boards

They are made of teak wood in different sizes and are specified in length × height

Iron Boards

G.I boards and M.S sheet boards are also in use and are specified like wooden boards.

Wooden Screw

Iron and brass screws are in use for fixing wiring base materials on gullies or plugs They

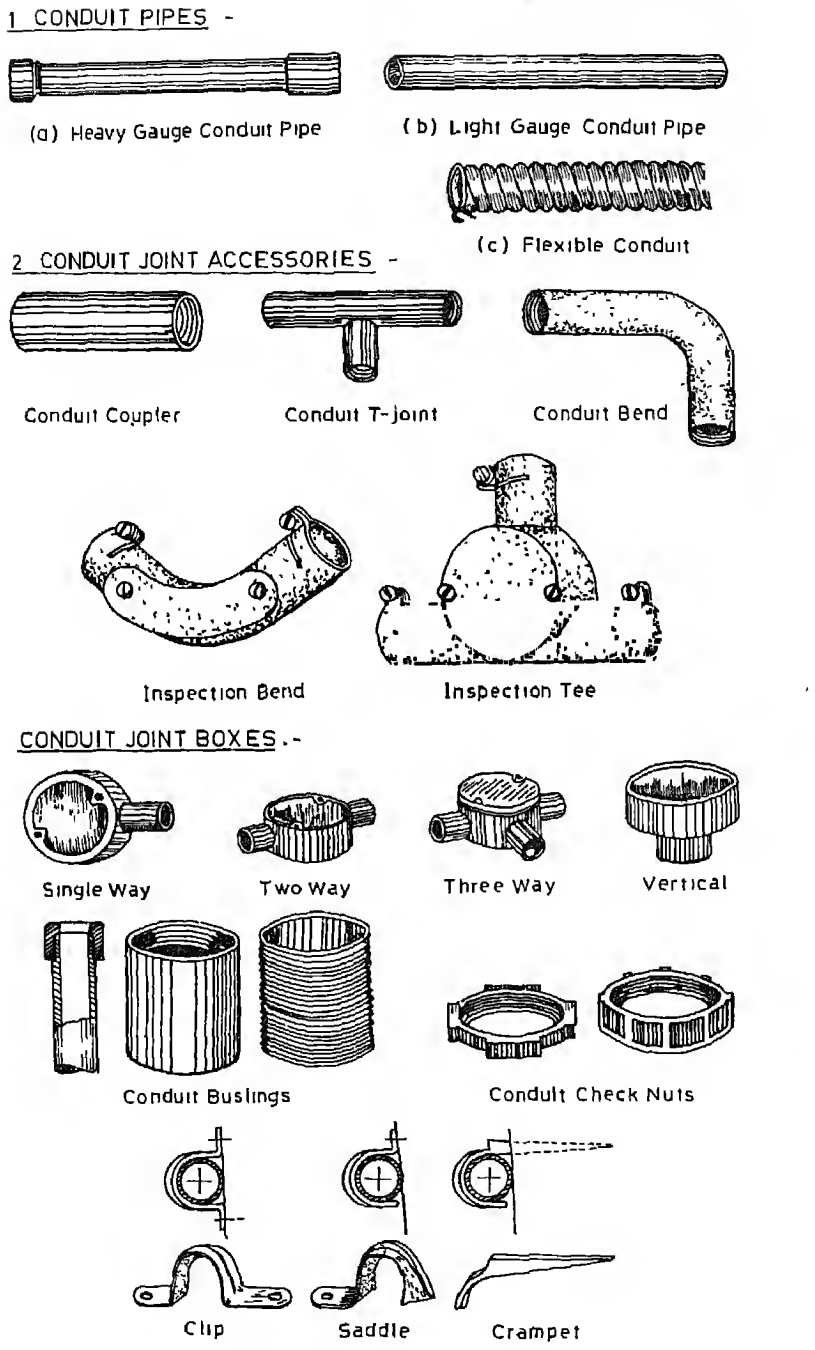


Fig. 24 1 Conduit and conduit Accessories

are specified in length

Conduit Pipes

Metal conduits are made from iron sheets in light gauge and heavy gauge in different standard diameters They are specified in material, gauge and dia Now a days PVC pipes are also in common use. It is a base material for wiring.

Flexible Conduit

Flexible conduits are also available in different diameters. They are portable base materials for wiring and specified like conduit pipes

Conduit Accessories

At joints, bends, terminals are crossings different conduit accessories are used like conduit couples, conduit bends (solid and inspection type), joint boxes, reducers, tees, bushings, check nuts and lock nuts, etc. For fixing conduit pipe on wall conduit clip, saddles and crampets are used.

Cable

Cables of copper and aluminium are used for wiring. Now a days, PVC cables are in common uses. Cables are having single core, double core, three core and three and half core constructions in different sizes. Cables are specified by insulation conductor materials number of cores and size of conductor, either in mm^2 or in number of wires × SWG of wire. To connect portable appliances and terminal connections flexible copper cables are used specified by number of wires × SWG of wire.

The different accessories used in wiring to correct appliances to the wiring circuit and to control and protect the system are as below :

Switch - Fuse Units

These are the accessories to protect and control the wiring system at start of the wiring. It is a combine switch and fuse unit having switch to On/Off the supply and fuse to protect the wiring/appliance under short circuit These are mainly of two types

(i) Double pole (DPIC) and
(ii) Tripple pole with neutral (TPNIC)

These are specified in type, current and voltage. These are used to control supply main and are called main switch.

Single Pole Switches

To ON/OFF single phase light, fan heating, power appliances single pole switches are used These are of bakelite construction with porcelain base. Switches are typed as surface type and flush type based on its method of mounting. These are specified in number of ways, type, constructional material, current and voltage. Switches are of single way and two way forms

Ceiling Rose

It is made of bakelite and is used to connect supply terminal to light and fan. It has two or three terminal points in it It is specified in number of terminals, current and voltage.

Push Switch

It is a single pole single way switch. It is available in different shapes and mounting and is used like push-button of a call bell. It is specified in shape, mounting, current and voltage.

Sockets

These are the power outlets in the wiring for single phase portable appliances. Sockets are with two terminal holes or three terminal holes called two-pin or three pin sockets. The third pin is for earthing. They are made of bakelite with porcelain base in round or square shapes. Sockets are specified with construction material, number of pins, shape, mounting, ampere and volts

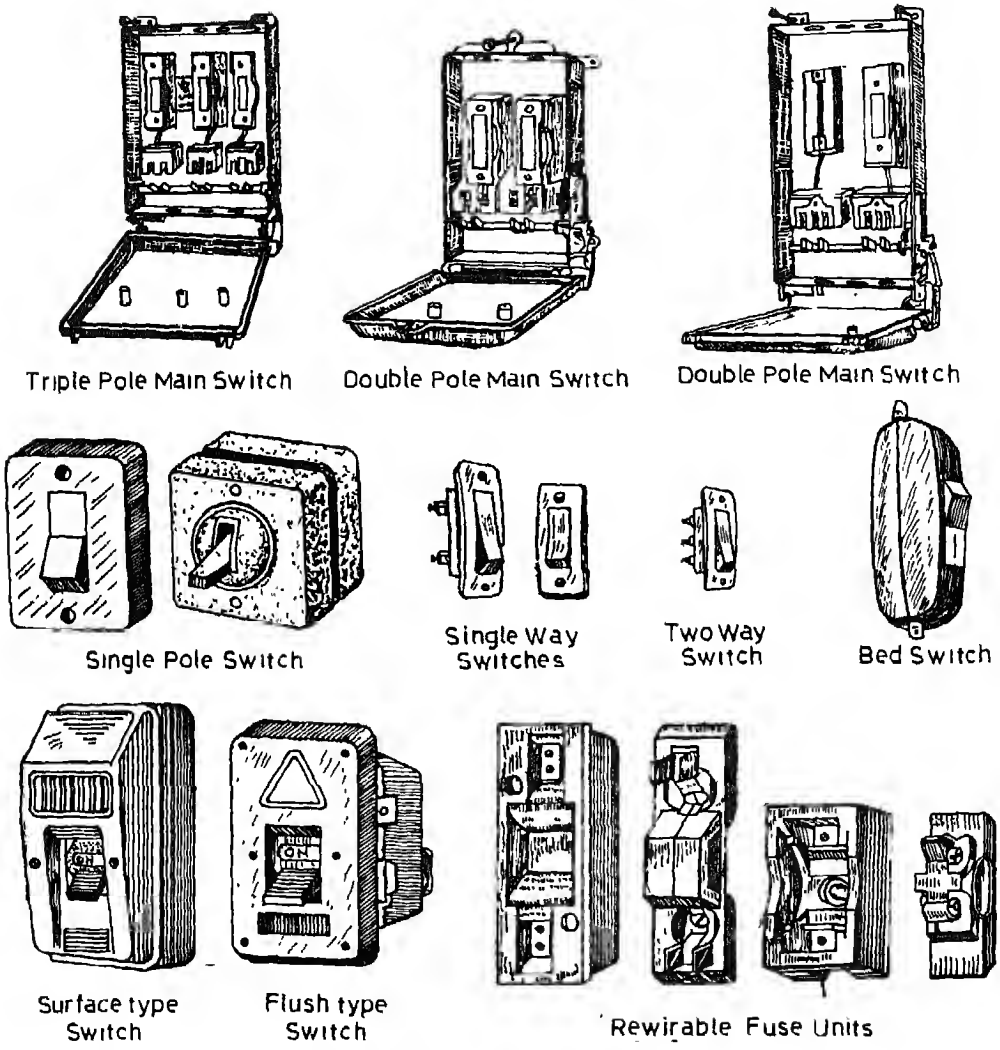


Fig. 24 2 Main switch, switch and fuse

Fuse

It is a unit to continue the electrical circuit through a low melting point wire element called fuse wire. Fuse is provided at the start of a wiring circuit to protect the wiring from short circuit For low current it is normally a rewireable type and for high current HRC type The fuse is specified in type, amperes and volts

Switch, Fuse and Socket Unit

Now a days combine units are also available in the market as switch-socket unit or switch-fuse-socket units for domestic light-fan and power wiring

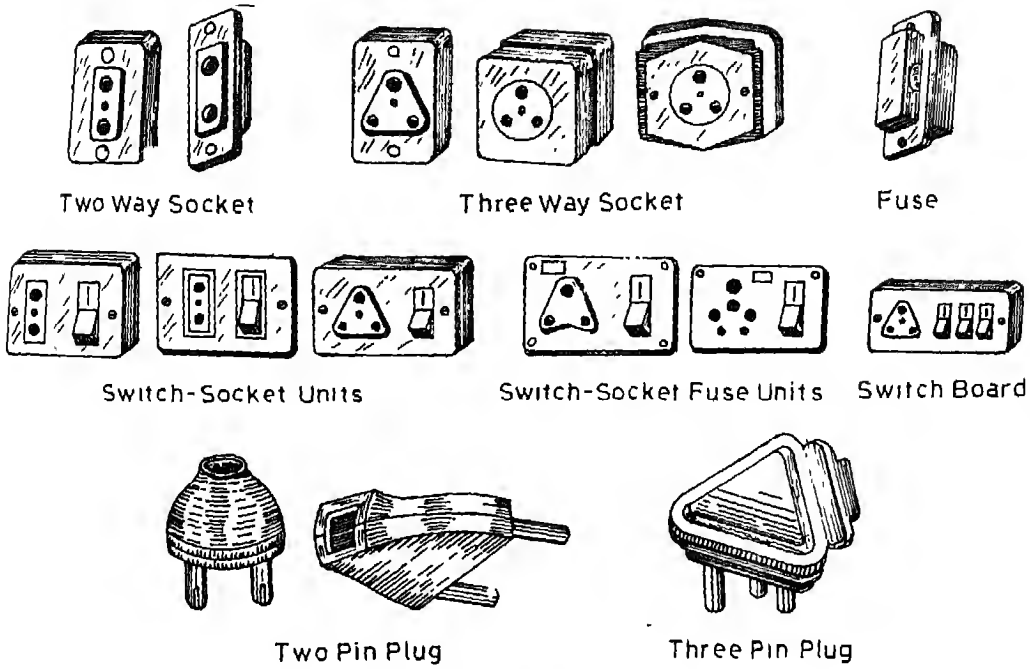


Fig. 24 3 Socket and plug

Plugs

To connect single phase portable electrical appliances to wiring circuit the unit used is known as plug It is available in different shapes but in two or three terminal construction only called two pin or threee pin plugs The third pin is for earthing Plug is specified in number of pins, ampere and volts

Lamp Holders

To connect different types of bulbs/lamps in wiring, circuit-outlet points are given through lamp holders in different ways as per requirements The common lamp holders are

(i) Batten holder – mounted on board or round block
(ii) Bracket holder – mounted on metal pipe construction called bracket
(iii) Pendent holder - suspended through fluxible cables
(iv) Angle holder – mounted on board or round block

The different wiring materials and accessories are given here in Fig 24 1, 24.2, 24.3,24 4, and 24.5

Equipment and Materials

(i) Different wiring materials
(ii) Different wiring accessories
(iii) Screw driver set
(iv) Series test lamp
(v) Ohmmeter
(vi) Series-parallel supply board
(vii) Display board for wiring materials and accessories

Procedure

(i) Identify and study different wiring materials with their specifications with the

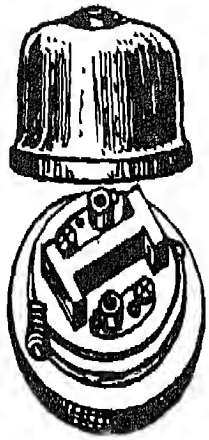


Fig. 24 4 Ceiling rose

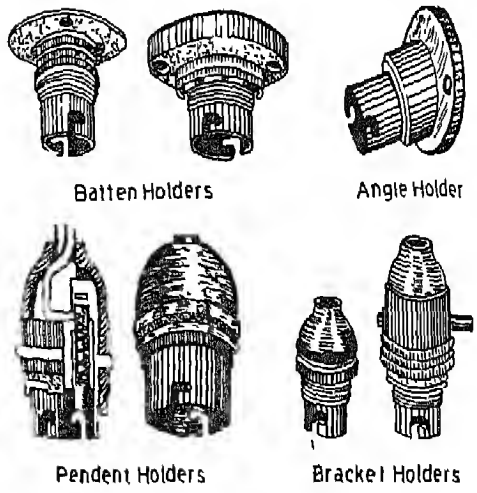


Fig. 24.5 Lamp holders

help of display boards

(ii) Identify and study different wiring accessories with the help of display boards and note their specifications.

(iii) Open the covers of different wiring accessories and study and test their electrical circuits

(iv) A brief note of construction, operation, specification and use should be made during study, as far as possible.

(v) Connection and termination of cables should also be learned carefully during study and identification.

Precautions

(i) Each accessory should be opened carefuly.

(ii) After making study and notes each accessory should be completely and properly closed.

Questions

(i) Name different types of wiring materials and their application.

(ii) State specification of wiring clip, conduit pipe and board.

(iii) Name different types of lamp holders and state their applications.

(iv) What are different types of single pole switches? State specification for each.

(v) What is a switch-fuse unit? Give specification for each unit.

To Practise Wiring Installation of Single Phase and Three Phase Motors

Specific Objectives

(i) To acquire skill in installation of single phase and three phase motors.

(ii) To acquire knowledge of connecting wiring accessories, control and protecting equipments in single phase and three phase circuits.

Related Information

Wiring installation of motor is a part of industrial wiring and is done with conduit. It includes laying of conduit and conductors and also connecting protection and control equipment in the circuit starting from supply mains to motor terminals

The wiring installation layout of a three phase motor is shown in Fig. 25.1 with its electrical circuit arrangement shown in Fig 25 2 The three-phase motor circuit requires a TPIC switch-fuse unit as main switch, and starter for operation and control of the motor The conductor size required here depends on the rating of the motor and conduit and its accessories required depends on the size of conductors. This wiring installation is also done using cable of required size.

The installation layout of a single phase motor is shown in Fig 25 3. It also requires control, and protecting devices in the circuit including main switch and starter.

Earthing is an essential requirement of wiring installation. The motors must effectively earthed by double earthing.

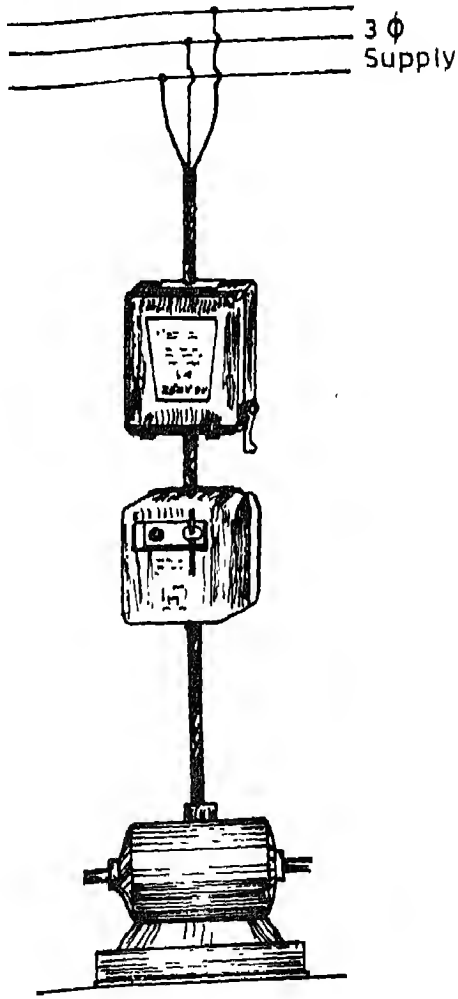


Fig. 25 1 Layout for a three-phase motor

Equipment and Materials

(i) Insulated pliers 20 cm

(ii) Screw driver 15 cm
(iii) Connector screw driver
(iv) Knife
(v) Line tester
(vi) V I R wire 7/029 (7/22) 500 volts 20 mts.
(vii) Insulating tape 2 mts.
(viii) Single phase induction motor 3' HP 250 volts 50 Hz
(ix) Squirrel cage induction motor 5 HP 400/440 volts 3 phase, 50 H'z
(x) Current limiter for single phase motor
(xi) I C D P 30 A,P.250 volts (single phase)
(xii) I C T,P 60 Amp 440 Volts (3 phase)
(xiii) D.O L starter for 3 motor
(xiv) Test lamp
(xv) Megger
(xvi) Multimeter

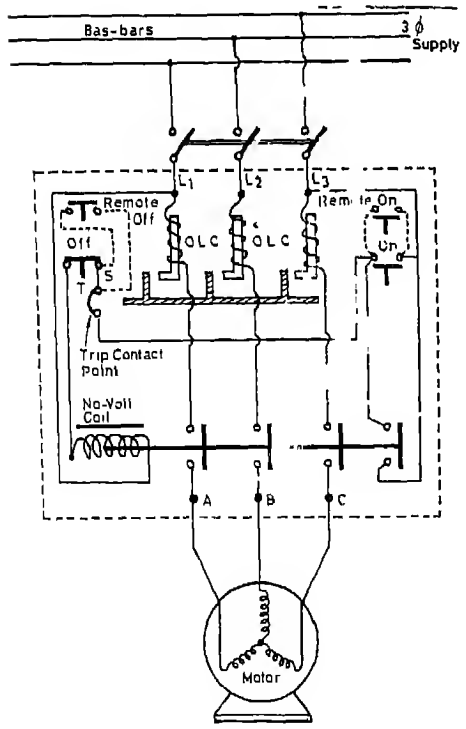


Fig 25 2 Connection diagram for a three-phase motor

Procedure

A Single Phase Motor Wiring

(i) Read and observe figure 25.3
(ii) Mark positions for laying out the line on the place where it should be installed.
(iii) Make concrete bed for foundation of motor with correct alignment
(iv) Keep the motor on the concrete bed with alignment horizontally
(v) Check energy meter, current limiter, ICTP for working continuity by series test lamp or megger or ohmmeter
(vi) Fix all the apparatus as per layout
(vii) Test the motor for continuity, short circuit, open circuit, and coil sequence for connecting the terminals by test lamp
(viii) Sleeve the ends of wires to the required sizes for connection.
(ix) Connect the motor as per Fig 25 3
(x) Connect a switch and socket with indicator on 6" × 8" teak wood board
(xi) Check for any loose connections in the terminals
(xii) Before running the motor check for any wrong connection.
(xiii) Run the motor by putting 'ON' the switch
(xiv) Switch off the motor after observation

B Three Phase Motor Wiring

(i) Read and observe the figures 25 1, 25 2.
(ii) Make measurements on the place where the installation should be provided
(iii) Mark the lay out diagram for the markings.
(iv) Open direct on line starter and observe the internal diagram for connection
(v) Tighten the connections in the starter
(vi) Test the motor for the continuity, open and short circuit and see for loose movement of the rotor
(vii) Make concrete bed for motor fixture

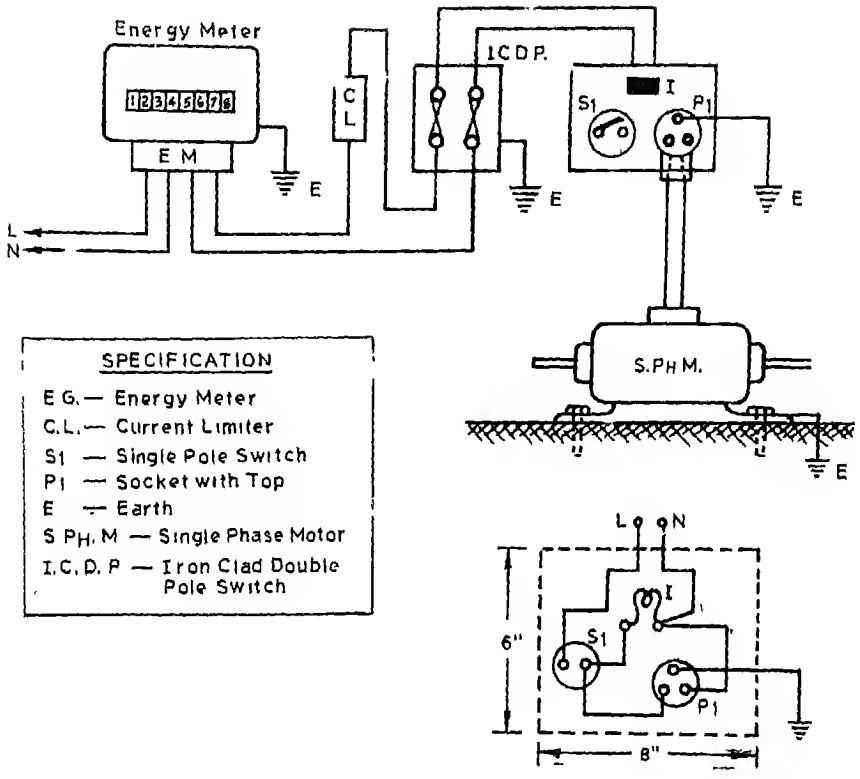


Fig. 25.3 Connection of a Single Phase Motor

(viii) Fix the motor on the concrete bed after alignment

(ix) As per figure 25 2, sleeve out the wires and do the wiring of the motor

(x) Check for the loose connection and tighten them

(xi) Before running motor make sure all the connections are correct

(xii) Now 'ON' the motor by pressing the green button on the DOL starter, the motor starts rotating if the connections are correct

(xiii) 'OFF' the motor by pressing the red button on the DOL starter for reverse rotation

(xiv) Interchange any two terminals for reverse rotation.

(xv) Two earthing should be done for the motor and all the metal parts of apparatus should be earthed

Precautions

(i) All the connections should be tight and clean.

(ii) While connecting starter, take care that connecting wires do not obstruct any moving part

(iii) For short circuit protection, fuses of suitable rating should be used and checked before starting the motor.

(iv) Make double earthing for motor, starter and main switch

(v) Magnet faces must be kept clean, otherwise there will be humming due to loose contact

(vi) Use oil for lubricating on magnet faces to reduce humming.

(vii) To reverse the direction of rotation of motor, interchange two phases in the terminals

(viii) First close the main switch and then press the green button of starter for tarting

(ix) The main switch and the starter of the motor must be very near to the motor

(x) The connection from starter to the motor should be done in flexible conduit pipe and the length of the flexible conduit pipe must not exceed more than 1 metre.

Questions

(i) What are the components of wiring installation circuit of three phase motor ?

(ii) What are the components of wiring installations circuit of single phase motor ?

(iii) How are the ratings of different control and protective devices decided?

(iv) How are the ratings and sizes of conductor and conduit decided ?

(v) What are the precautions observed during instal' tion of a wiring circuit ?

(vi) State the procedure of wiring installation for three phase motor.

To Identify Common Lubricants and Practise the Lubrication of Electrical Machines

Specific Objectives

(i) To develop a concept of friction between two moving surfaces and need of lubrication

(ii) To develop knowledge about important properties of common lubricants.

(iii) To develop the knowledge about the practices used in lubrication.

Related Information

Every machine is composed of several sliding and rotating parts which have relative motion. This makes the parts to rub against each other No matter how finely machined and highly polished, the movement is resisted by a force called friction force. If the surfaces are continued to move under such conditions, heat will be generated causing wear and tear to the moving surfaces and resulting in ultimate failure of the sliding parts To reduce this frictional force, a layer of some fluid is introduced between the two running metal surfaces, to keep them apart. This fluid is called the lubricant.

When the rubbing surfaces are perfectly lubricated with some oil, a thin film of oil is entrapped between the surfaces, preventing metal to metal contact and the frictional force is now due to the shearing across the adjacent layers of oil. This force is dependant upon the 'viscosity' of the oil used as lubricant Viscosity is a property of lubricant More the force required to shear the layers of lubricant more viscous it is said to be. Thus when two moving metal parts are properly lubricated with a proper lubricant, there is no chance of metal to metal contact taking place at all, and the lubrication is called 'fluid lubrication'. In inadequate lubrication, metal parts may come in contact occasionally and then the lubrication is called 'boundary lubrication', in which case the friction coefficient is 10 to 25 times higher than that for 'fluid lubrication'. However, even boundary lubrication friction coefficient is very much below the dry friction coefficient when there is no lubrication.

Thus, a proper lubricant is a fluid which can form a film between two moving metal surface and maintain that film all round at its working speeds at ambient temperature If the film breaks at some speed or temperature the lubrication becomes inadequate.

The most common lubricants are the oils and greases. Water is also a lubricant at some places. A few solid substances like graphite, soap stone, talc, mica, etc. are also used as bearing lubricants.

The choice of a lubricant depends upon the speed and temperature at which the components are subjected and the intensity of pressure between the mating surfaces.

The following properties of lubricants govern their selection:

(i) 'Viscosity', which provides surface tension to the lubricant and is necessary to maintain its flow through the bearing. Viscosity decreases with the rise in temperature

(ii) Oiliness, which is responsible for maintenance of a continuous film of oil upon mating surfaces at a load. More the load on the mating surface, more oily lubricant is

required to be used

Vegetable oils are more oily than mineral oils

(iii) Flash point, is that temperature at which the lubricant starts burning This temperature should be much higher than the working temperature of mating components

(iv) Volatility, is the property of a lubricant which helps to evaporate at working temperature. The lubricant used should be less volatile

(v) Oxidation, is the property due to which the lubricant may get oxidised coming in contact with oxygen or air Vegetable oils are more prone to oxidation than mineral oils Mineral oils are highly resistant to oxidation

Types of Lubricants

There are mainly 3 types of fluid lubricants

(i) Mineral oils, obtained from distillation of crude petroleum These are different grades of mobile oils marketed in different names

(ii) Vegetable oils, extracted from vegetable seeds, e g castor oil, olive oil.

(iii) Compound oils, which are blended mixtures of (i) and (ii) or some chemicals are added to improve their usability as lubricants These chemicals are called additive.

Lubrication Methods

The machine bearings are lubricated in a number of ways The following are a few of the common methods adopted

(i) HAND OILING

The bearings subjected to light loads and operating at slow speeds are lubricated by this method. Only a hole is provided leading the point of lubrication and lubricant is dropped with an oil can.

(ii) NEEDLE LUBRICATION

The method is suitable for the lubrication of horizontal bearings where load transmitted is moderate and works at medium speed In this a glass bottle is fitted with a stopper, through which passes a needle as shown in Fig 26 1

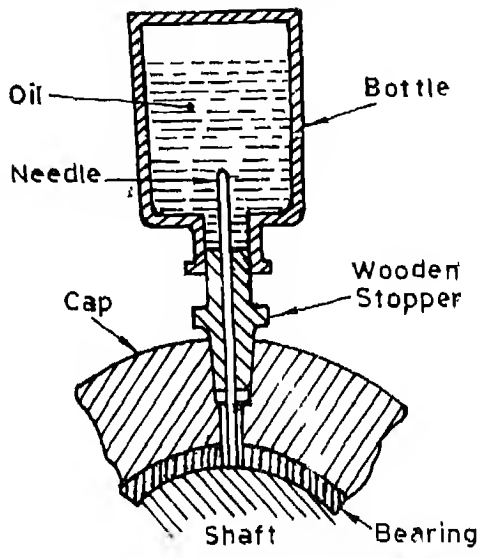


Fig. 26.1 Bottle lubricator

(iii) WICK LUBRICATION

The system works on syphon or capillary principle The wick is pulled up when the machine is not working so that there is no flow of oil when not required. The cup is fitted over the housing of the hearing. This is shown in Fig 26 2

(iv) GRAVITY LUBRICATION

Here the supply oil is entirely by virtue of gravity It is also known as drop feed lubricator The opening of hole at the bottom of the cup can be adjusted by lifting or lowering of the lever. The supply is started by opening the hole, as and when

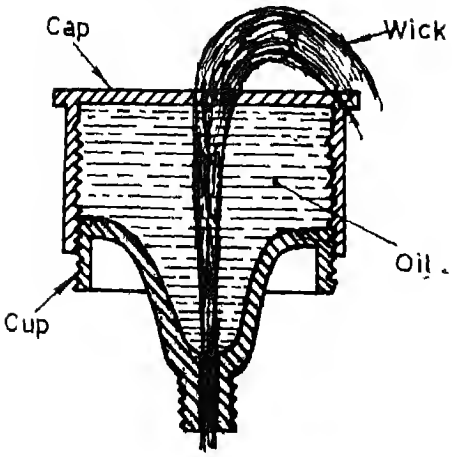


Fig. 26.2 Wick lubricator

required. This is illustrated in Fig.26 3.

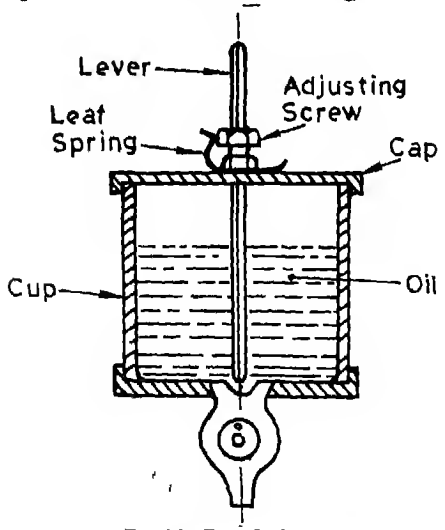


Fig 26 3 Drop-feed lubricator

(v) RING LUBRICATOR

The method is commonly used for lubricating horizontal bearing motors, generators and line shafts The arrangement consists of a large size ring which rests freely on the surface of the shaft or journal supported in the bearing, a part of which (bearing) is cut away to allow the ring to pass into the oil swamp, below the bearing As the shaft rotates, the ring also is carried along with it (due to friction) so that the oil from the swamp smeared to the ring is taken to the top of the shaft from where it is distributed to the entire length A single ring can lubricate 100mm shaft length This lubrication is automatic and reliable, but is suitable at medium speeds At slow speeds the ring may not move at all and at high speeds the rings may slip Some times rings are replaced with chains for better performance. Ring lubrication is shown in Fig.26 4.

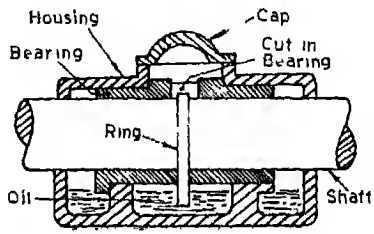


Fig. 26.4 Ring lubricator

(vi) GREASE LUBRICATION

Mating parts where clearance is high, or in ball and roller bearings, grease lubrication is adopted Grease is stuffed in a grease cup and squeezed into the mating surface by turning the cap, or just with a grease gun This is shown in Fig 26.5

Observations

(i) Look for different types of lubricants fluid, semisolid and solid, and identify each of them

(ii) In repair shop, look for the lubrication points and the lubricants used, and tabulate your observations

Precautions

(i) While searching for lubrication points see that the machine is switched off from line

S No	*Name of Machine*	*Lubrication points*	*Type of Lubrication*	*Type of Lubricant*	*Remarks*
(i)					
(ii)					
(iii)					
(iv)					
(v)					

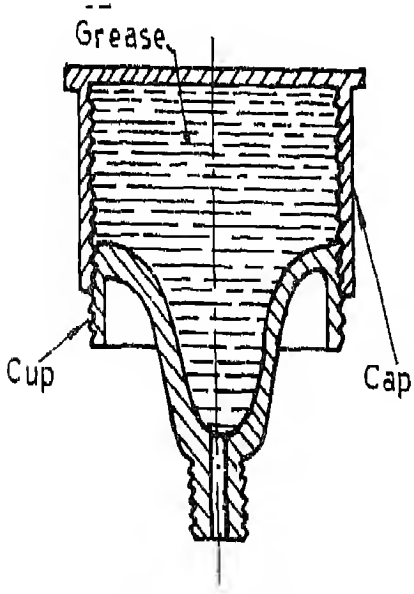


Fig. 26.5 Grease lubricator

(ii) Do not over lubricate.
(iii) Do not waste lubricants

Questions

(i) Explain clearly how the lubricant works.

(ii) On what factors does the selection of a lubricant depend ?

(iii) Sketch the following lubricators and explain their working

(a) Ring lubricator

(b) Grease cap lubricator

(c) Wick lubricator

(d) Bottle lubricator.

(iv) Describe the different properties of lubricants.

(v) Can water be used as a lubricant and explain its disadvantages?

To Identify Common Types of Paints Used for Machine Housing and to Practise Painting

Specific Objectives

(i) To identify different types of ready mixed paints and select the suitable for this purpose.
(ii) To develop a knowledge of different ingredients present in paints.
(iii) To prepare the surface of machine part.
(iv) To paint with brush (manually).
(v) To do the painting by spraying technique.

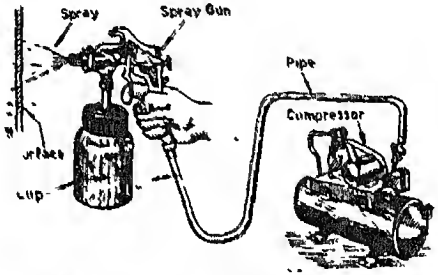


Fig. 27.1 Spray painting unit

Related Information

Painting is done to protect the surface from the effect of environment, i.e. corrosion. It has also an aesthetic value which is equally important.

When some specific type of solid materials are mixed with some specific type of liquid material to form a colloidal solution, the mixture is called paint. The powdered solid material is called the 'base' and the liquid as 'vehicle'. The base materials are mostly white lead, zinc white, red lead and iron oxide, etc. The vehicles used are linseed oil, olive oil, petilla oil etc. Colour pigments are used to give the paint a desired colour. Some drying agents are added to the mixture for fast drying. For making the paint thinner, i e. to desired consistency thinner, like turpentine oil, spirit, petrol, benzine, etc are added to it To reduce shrinkage on drying, filler materials, like chalk, charcoal, porcelain clay, barium sulphate, etc. are added.

The colouring pigments used are :
Black colour – Carbon black
Blue colour – Cobalt oxide, Indigo, etc.
Green colour – Chrome oxide, Blue Vitriol, etc.
Yellow colour – Ocher, Lead chromate, etc.
Red colour – Red lead, Vermilion, etc.
White colour – White lead, Zinc oxide, etc.

Now a days, it is customary to use ready mixed paints of different qualities available in the market in sealed containers, which give better finish and are long lasting.

The most important point to be kept in mind while painting is to adopt a procedure which will give a lasting painted surface with proper adhesion.

The paint may be applied on the surface either by brush manually or with a spray gun.

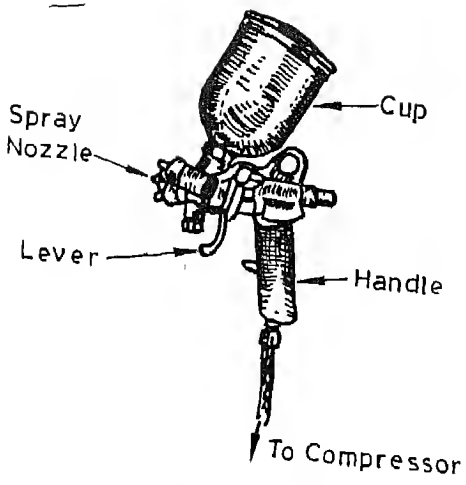


Fig 27.2 Spray gun

Equipment and Materials

(i) Ready mixed paint
(ii) Thinner
(iii) Emery paper
(iv) Caustic
(v) Primer
(vi) Putty
(vii) Brushes flat and round
(viii) Spray painting unit with compressor
(ix) Pickling acid

Procedure

(i) Clean the surface to be painted, thoroughly using any of the following methods, whichever is the most suitable
(a) Manually with scrapers, emery paper, soap, caustic soda, hard brush, steel wool, etc.
(b) Blasting method with a sand or shot blasting machine
(c) Flame cleaning with the OXY-acetylene flame
(d) Acid pickling with or without detergent powder Hydrochloric acid, sulfuric acid or phosphoric acids are used

(ii) Check that all rust, grease, oil, scales have been completely removed and metallic lustere comes on the surface to be painted

(iii) Make the surface smooth using emery paper.

(iv) Fill the dents and pits with putty and make the surface uniform and smooth using emery paper

(v) Mix the wash primer with phosphoric acid and apply the mixture immediately after cleaning the surface (wasl. primer is a mixture of zinc chromate in Polyvinyl resin)

Note Red oxide primers are also used on iron surfaces before painting, in place of zinc chromate

(vi) Apply the first coat of paint on this surface The method used may be one of the following.
(a) Hand or brush painting
(b) Spray painting
(c) Dip or emersion painting.

Hand Painting

(vii) Apply paint with a flat brush on flat surfaces and with round brush at irregular surfaces and holes Move the brush from top and towards bottom Use minimum quantity of paint and draw it as much as you can (Thin paint sticks to the surface and do not peel off but thick coats crack, wrinkle and peel off)

(viii) Allow the coat to dry completely Sand the surface lightly to remove dust deposited during drying and apply the second coat as required
Normally two coats shall be enough

Spray Painting

(ix) Prepare the paint for spray painting by adding thinner to get required consistency

(x) Fill this paint in the spray gun cup and

apply the first coat by spraying from top moving the gun horizontally at uniform speed The gun should be moved from left to right and from top to bottom

(xi) Allow the surface to dry up completely After hardening of the surface, sand the surface lightly with fine emery paper (water proof) for removing the dust collected on it during drying

(xii) Apply the second coat in the same manner

Precautions

(i) The surface to be painted must be dry, free from oil, grease, dust, rust, etc

(ii) The painting should be avoided in humid weather

(iii) Open air rich in oxygen is necessary for the paint to dry

(iv) Painting should be done in dust free chamber

(v) The brush used should be of good quality so that its bristles do not give way and stick to painted surface.

(vi) The brush should be cleaned with thinner and then kerosene oil immediately after use otherwise the paint in it will dry up and make the brush unusable

(vii) Keep the lid of the paint container always covered and take out only small quantity at a time for use

(viii) Always stir the paint before taking it on brush.

(ix) Do not keep fire near paint

(x) Always clean the spray gun nozzle before and after use

(xi) Select the correct size of nozzle and cup for the spray gun

Questions

(i) What is paint ?

(ii) What are the objectives of painting ?

(iii) What are the advantages of painting a job?

(iv) State the different base material, vehicle material and colouring pigments used in paints

(v) What faults may occur on a painted surface if the surface has not been prepared well?

(vi) What is the function of primer ?

(vii) What material is used as primer ?

(viii) How pickling is done ?

(ix) What factors are kept in mind while selecting a painting brush ?

(x) Draw sketch of a spray gun and describe its working ?

(xi) What are the advantages of spray painting ?

(xii) Describe briefly how a surface is prepared for painting ?

To Study the Application of Common Mechanical Power Transmission Methods

Specific Objectives

(i) To develop the concept of different methods of mechanical transmission
(ii) To appreciate the working of a power transmission system coupled to a prime mover.
(iii) To study different methods of transmission and their applications.

Related Information

A mechanical drive is a mechanism intended to transmit power from the primemover (motor) to the machine, usually involving a change in velocity, force and torque, and sometimes in its nature and direction

Transmission System

The transmission system linking the prime mover and the machine is required due to the following reasons :

(i) Velocity of the motor is different from the velocity of the operating machine.
(ii) The motor velocity is mostly fixed whereas the machine is required to be operated at different velocities.
(iii) The torque available at the motor shaft is taken as constant whereas the machine operation may require torques far in excess of that.
(iv) Standard motors are designed for uniform rotary motion whereas the machine operating members may have to move either rectilinerly or oscillate about an axis.

The above objectives are nowadays achieved with the help of mechanical drives together with hydraul, pneumatic as well as electrical transmission system

Types of Drives

Mechanical drives are broadly classified as :

(i) Transmission by friction mesh (belt and pulley or friction wheels)
(ii) Transmission by positive mesh: The positive transmission may be with :
(a) Direct contact (as in toothed and worm gears)
(b) Flexible connection (as in chain drive).

Friction Wheel Drive

The simplest drives of this type are composed of two wheels (rollers), driving and driven, which press against each other with such a force as to make the frictional resistance between them equal to the transmitted peripheral effort. The required pressure can be permanent or variable. The permanent pressure is produced by weight of the machine, lever or spring. Variable pressures are produced by special devices. Advantage of friction drive is that they are simple in design and operate noiselessly. The different types of friction drives are shown in Fig.28.1.

The limitation of friction drive is that maximum power that can be transmitted never exceeds 200-300 H.P.

Belt Drive

Another type of friction drive is through belt

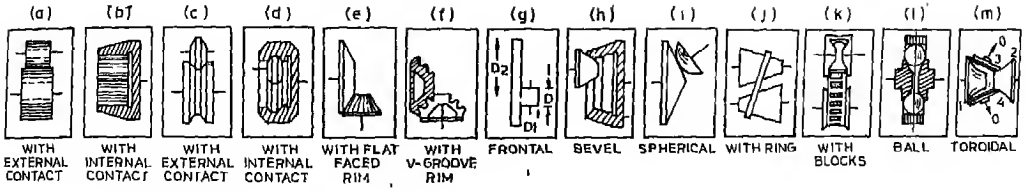


Fig 28 1 Types of friction wheel drives

and pulley In its simplest form a drive of this type consists of an endless belt fitted tightly over two pulleys–driving and driven-transmitting motion

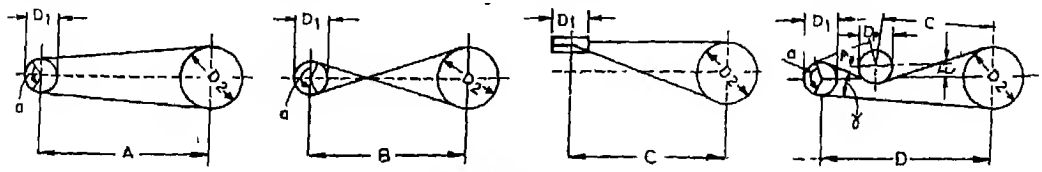


Fig. 28.2 Belt drives

from the driving to the receiving pulley by frictional resistance between belt and pulley

Different types of belt drives are shown in Fig 28.2 They are classified mainly by the type of belt and the way tension is produced

In belt drive, there are great transmission losses due to

(i) Creep of the belt on the pulleys

(ii) Air resistance to the movement of the belt, pulleys and idler pulleys

(iii) Friction in the leasings due to pulley tension

The belts may be flat type or vee type, and made from leather, woven canvas, woven wool or rubber The ends of the belts are jointed differently to give different joint strengths. These are shown in Fig 28 3

Toothed Gear Drive

Toothed gears have found wide application in the field of transmission of power This type of drive system are distinguished by high degree of efficiency, compact layout, reliable service and simple operation

The toothed gear drives are mainly classified according to

(i) Mutual position of shaft

(a) Parallel shafts – Spur gear

(b) Inclined shafts – Bevel gear.

(ii) Number of steps, giving one, two, three and multistep gears

(iii) Relative motion of shafts, giving internal and external gear planitary trained of gears.

(iv) Transformation of motion from rotary to transitory, or vice versa in rack and pinion system

Large horse power at variable speed (selectable) are transmitted by toothed gear drive in almost every field The only disadvantage of this drive is its noise Types of gear drives are shown in Fig 28 4

Worm Gear Drive

Worm gear drive is used to transmit very large horse power of the order of several hundreds of kilowatts at a high velocity ratio This is shown in Fig 28 5

Worm gears offer the following advantages

(a) Compact layout

(b) Dependable operation and simple maintenance

(c) High velocity ratio

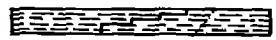
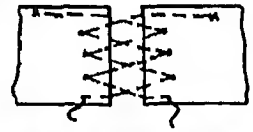
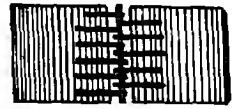
	TYPES OF JOINT		Joint strength relative to the strength of integral belt in %
CEMENTED JOINTS	Cemented Leather		80-85
	Cemented Rubber		80-85
LACED JOINTS	Rawhide Strips		30 50
	Twines		50
HINGED JOINTS	Bolts with Plates (Butt Joint)		30
	Bolts with Plates (Crest Joint)		25
	Wire hooks or Spirals with a Pin		50-80

Fig 28.3 Types of belt joints

The disadvantages of worm gears are as follows :

(a) Large power losses

(b) Need for high quality material (bronze), and

(c) cost

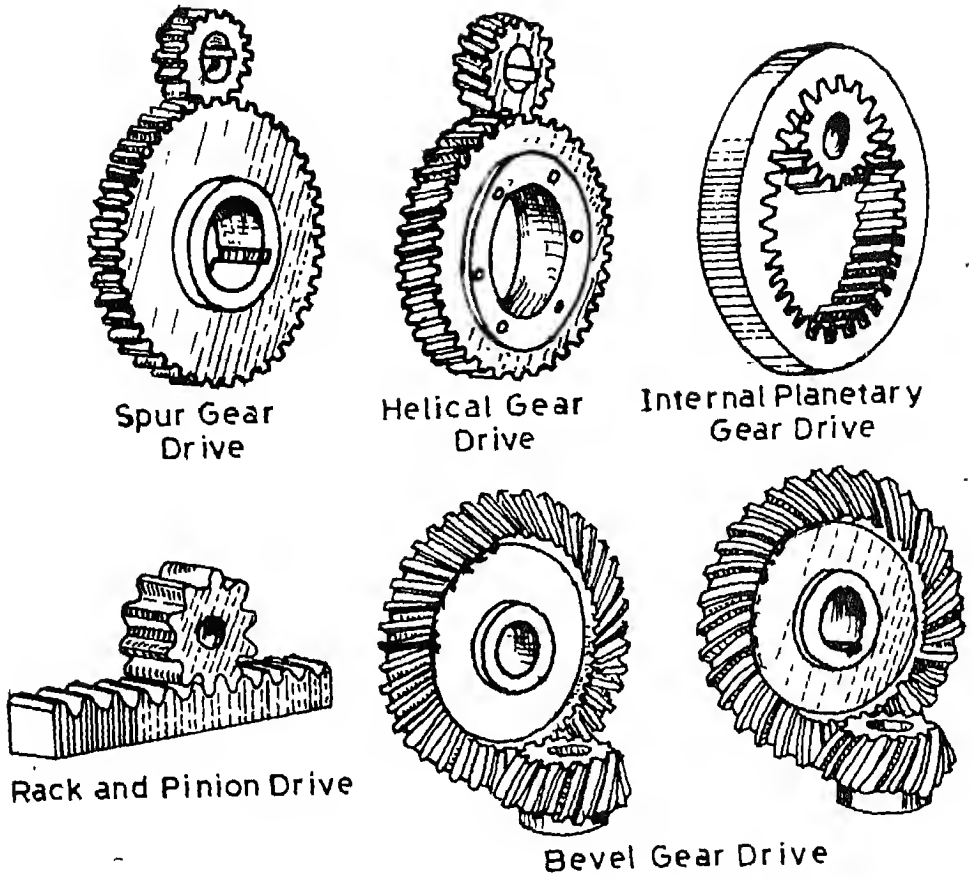


Fig. 28.4 Gear drive

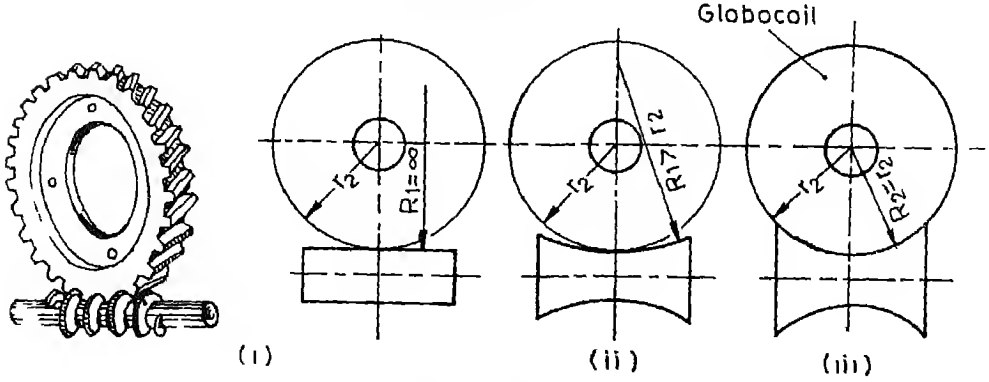


Fig. 28.5 Worm gear drive

Chain Drives

In simplest form a chain drive consists of a chain and two sprockets–driving and driven This is shown in Fig 28 6 Drives operating under severe load and at a high velocity are encased in a housing and provided with lubrication system The principal advantages of chain drives are follows

(a) Effective transmission of power when the distance between the shaft centres is large
(b) High efficiency (98%)
(c) Less load on the shaft compared to belt drive
(d) The ability of one chain to transmit motion

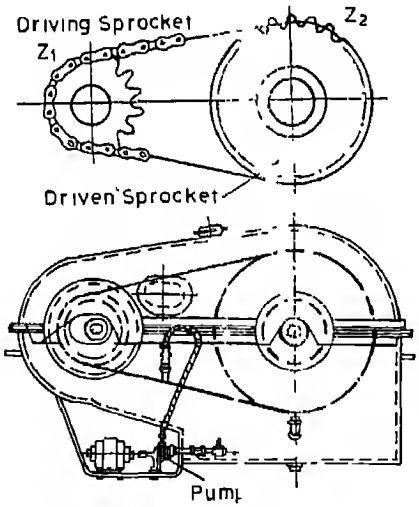


Fig. 28.6 Chain drive

to several shafts.

Chain drive is employed to transmit upto 150 H.P. at peripheral velocity upto 15m.

Power Screws

A power screw is employed to convert rotary motion into rectilinear motion. The advantage of this drive are

(i) Simple design
(ii) High velocity ratio
(iii) Self locking
(iv) Possibility of manufacturing it with a high pitch accuracy at comparatively low cost The only disadvantage is rapid wear and low efficiency

Couplings and Clutches

Couplings and clutches are intended to connect shafts or other revolving parts to link together the driving mechanisms to prime movers, or shafts of separate units and assemblies They protect against overloads and effect smooth starting, stopping, and reversal processes

They are of two general types

(i) Permanent couplings
(ii) Clutches

Couplings are used to make permanent connections between shafts, while clutches are used to connect and disconnect them.

Coupling of required size is chosen from standard tables on the basis of maximum torque to be transmitted

The couplings may be

(i) Rigid type (or box coupling)
(ii) Flexible type

These are illustrated in Fig 28.7 and 28 8

Rigid type couplings are used only where the shafts are strictly and constantly in alignment. Sometimes accurate and constant alignment cannot be ensured. In such cases flexible coupling are used

Procedure

Study the models/actuals of different types of power transmission system available to your motor repair shop one by one and record your observations in the table

Precautions

(i) While making the study on machines, see

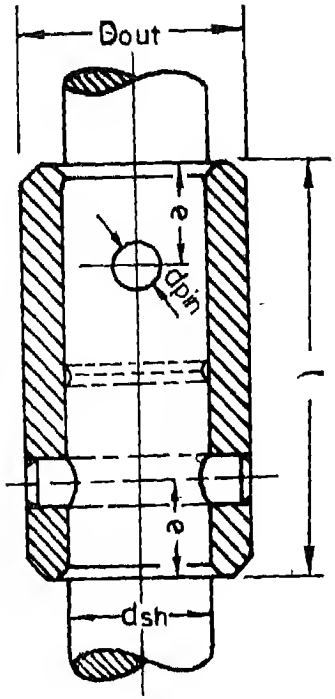


Fig. 28 7 Fixed type coupling

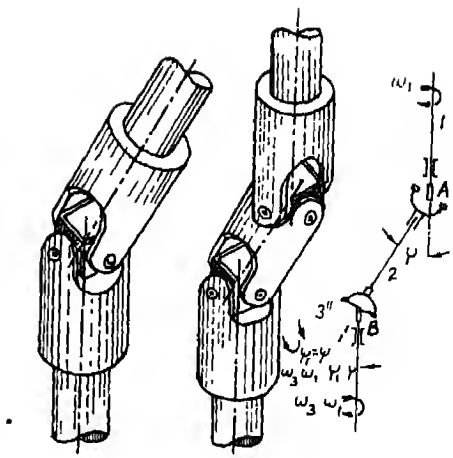


Fig. 28 8 Flexible coupling

that the m/c is not moving.

(ii) Observe safety and house keeping rules

(iii) Do not try to open or disturb the position of components

Questions

(i) Why are power transmission systems essentially attached to a prime mover ?

(ii) What are the different objectives that can be achieved with a mechanical drive system ?

(iii) Describe the application of friction wheel drives Give its limitations

(iv) Where are belt and pulley drives used ?

(v) What are the disadvantages of a belt drive?

(vi) Distinguish between friction drives and positive mesh drives

(vii) Describe how variable speeds can be obtained with gear drive

(viii) Give some application of gear drive

(ix) How are gear drives classified ?

(x) Describe chain drive and give its advantages.

(xi) What are the applications of worm drive?

S No	*Name of m/c or Model*	*From and To*	*Type of P.T. system*	*Remarks*
(i)	Drilling m/c	(a) Motor to spindle	Friction (Belt & Pulley)	
		(b) Spindle up and down	Rack and Pinion	
(ii)	Lathe m/c			
(iii)				
(iv)				
(v)				

ACTIVITY 29

To Practise Pipe Earthing

Specific Objectives

(i) To understand the necessity of earthing
(ii) To study the methods of pipe earthing.

Related Information

Earthing of electrical installation is required·

(i) To save human life from danger or shock, death in case of contact with charged frame due to package current
(ii) To maintain the line voltage constant.
(iii) To protect large buildings from lightening
(iv) To protect machines, equipment and O H. lines from lightning.
(v) As a return path for electrical current flow

The purpose of earthing is to provide as nearly as possible a surface under and around the electrical installation nearly at zero potential This is to ensure that all parts of apparatus, other than live parts, shall be at earth potential

For pipe earthing a 2mts. long G.T pipe of 38mm dia is embedded vertically in ground to work as earth electrode The depth at which the pipe is embedded depends upon the soil condition The earth wires are fastened to the top section of the pipe above the ground level with nuts and bolts The pit area around the G T pipe is filled with salt and coal mixture The pipe earthing with all specification of sizes depth etc is shown in Fig 29 1

Earthing should be provided to the following

(i) Installation in buildings
(ii) Domestic fittings and appliances
(iii) Industrial premises
(iv) Electrical driven M/c
(v) Electrical arc welding equipment
(vi) Industrial electronic equipment
(vii) Electro medical apparatus
(viii) Substation and generating stations
(ix) Overhead power lines
(x) Neutral wire of AC supply systems
(xi) Middle wires of the three wire D C distribution system

The resistance of the earth resistance depends upon the following factors

(a) Soil condition
(i) It should be wet marshy grounds containing refuse, such as ashes, cinders and brine waste
(ii) Clay and loan mixed with varying proportions of sand gravel and pebbles
(iii) Damp and wet sand pit
(b) Temeperature of soil is expected to be quite low, the earth electrode should be installed well below the frost line
(c) Waste contents of the soil resistivity of soil increases very abruptly with the decreases with increase in depth of embedding

Equipment and Materials

(i) G I. pipe 38mm diameter 2 5 m long
(ii) Reducing socket 38 × 19mm
(iii) G I pipe 19mm diameter 1m long
(iv) G I nut, washer, check nut
(v) Funnel, wire mesh
(vi) G I cover with CI frame
(vii) G I pipe 12 7mm diameter 80cm long

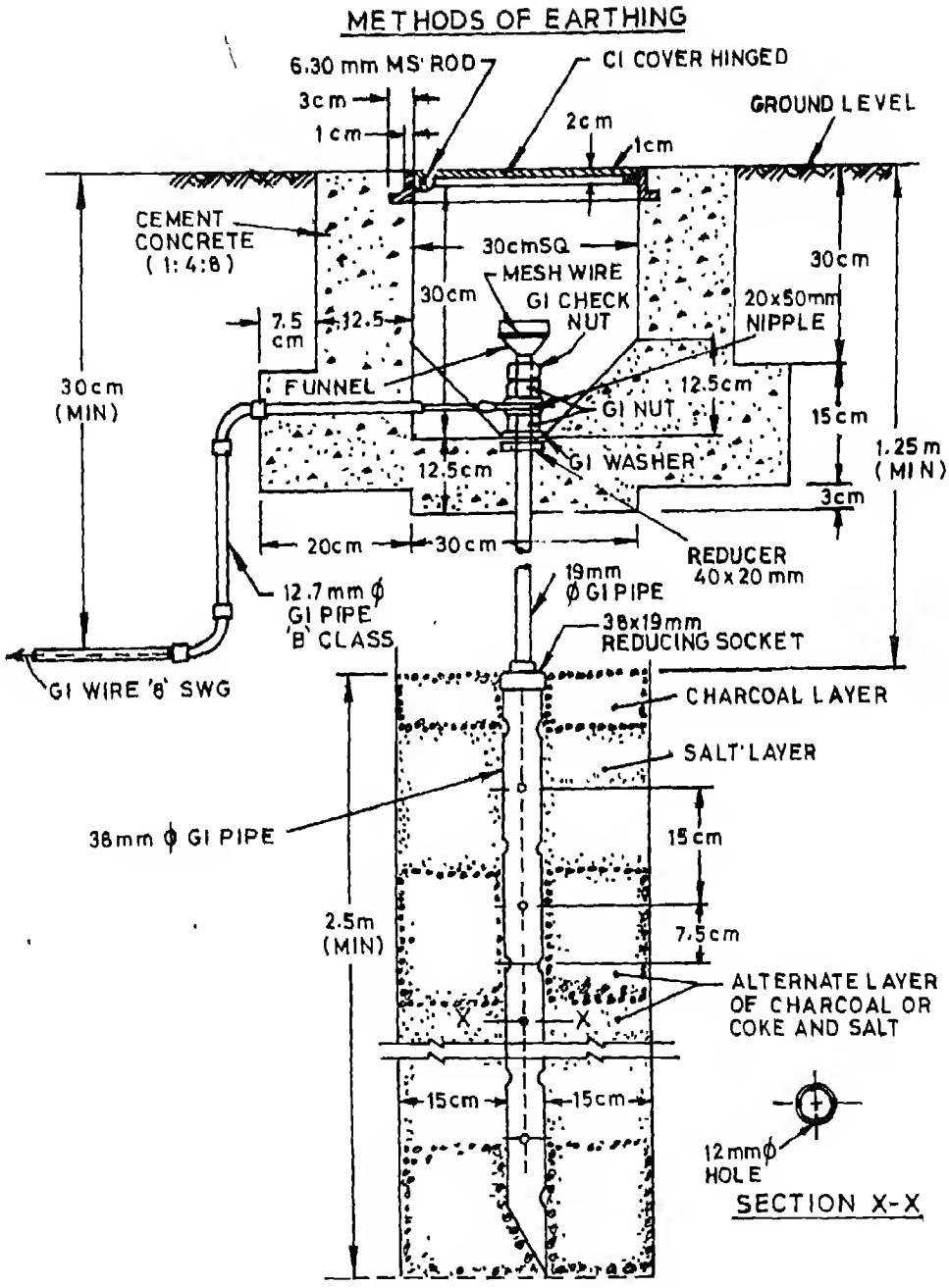


Fig. 29 1 Pipe earthing

(viii) Charcoal and salt
(ix) Cement concrete (1:4·8)

Procedure

(i) Mark on the ground where earthing is to be done as per requirement shown in Fig 29 1.
(ii) Dig a pit for earthing pipe as the case may be to the required depth
(iii) Put a layer of charcoal and salt and after fixing the pipe vertically Again the charcoal and salt to cover the pipe Ensure the earthing wire and pipe of funnel and pipe carring earthing wire are attached properly with pipe
(iv) Put the funnel at the top of funnel pipe with wire mesh.
(v) Concrete the area around the funnel and put CI frame with CI cover on it
(vi) Pour sufficient of water through funnel after solidifying concrete, for ensuring good earthing
(vii) Connect earth wire taken out through pipe to the equipment to be earthed

Precautions

(i) The earthing electrodes should be situated within 1.5 mts from the building whose installation is being earthed
(ii) The size of continuous earth wires used with cables should not be less than 14 SWG
(iii) Loose earth or coal salt mixture should be filled around the pipe for effective earthing
(iv) The size of earthwire run for earthing should be able to carry the full load current of installation offering least resistance to the flow of leakage current

Questions

(i) Why is earthing essential ?
(ii) What are the equipments and materials required for earthing ?
(iii) What is the depth of the earth digged ?
(iv) Draw pipe earthing with specification
(v) State the procedure for pipe earthing.

ACTIVITY 30

To Practise Plate Earthing

Specific Objectives

(i) To understand the necessity of earthing
(ii) To study the methods of plate earthing

Related Information

The earthing is essential

(i) To save human life from danger or shock, death in case in contact with charged frame due to leakage current
(ii) To maintain the line voltage constant
(iii) To protect large buildings from lightening.
(iv) To protect machines, equipments and OH lines from lightening
(v) As the return path for electrical transmission

The purpose of earthing is to provide as nearly as possible a surface under and around the electrical installation merely at zero potential This is to ensure that all parts of apparatus other than live parts, shall be at earth potential

In plate earthing the earth wire is bolted effectively with the earth plate of copper (size 60cm × 60cm × 3 18mm) or GI (size 60cm × 60cm × 6 3mm) embedded 3 metres deep in the ground Copper plates are found to be most effective earth electrodes and are not affected by oil moisture The earth wire is drawn through a G I. pipe fitted with a funnel on the top through which water is poured in the pit of each plate from time to time for efficient earthing This is shown with the size and specification in figure 30 1

Earthing should be provided to the following

(i) Installation in buildings
(ii) Domestic fittings and appliances
(iii) Industrial premises
(iv) Electrical driven machines.
(v) Electrical arc welding equipment
(vi) Industrial electronic equipment
(vii) Electro medical equipment
(viii) Substation generating stations
(ix) Over load power lines.
(x) Neutral wire of AC supply systems
(xi) Middle wires of three wire D C distribution system

The resistance of the earth resistance depends upon the following factors :

(i) Soil condition : It should be
  (a) Wet marshy grounds and grounds containing refuse, such as ashes, cinders and orine waste.
  (b) Clay and loam mixed with varying proportions of sand, gravel and pebbles.
  (c) Damp and wet sand pit
(ii) Temperature of soil is expected to be quite low The earth electrode should be installed well below the front line
(iii) Waste contents of the soil resistivity of soil increases very abruptly with decrease in moisture contents
(iv) Spacing and size of electrodes, resistivity decrease with increase in depth of embedding

Equipment and Materials

(i) G I plate 60cm × 60cm × 6 30mm
(ii) Copper plate 60cm × 60cm × 3 18 mm
(iii) GI pipe 12 7mm. diameter 1.5mts long.

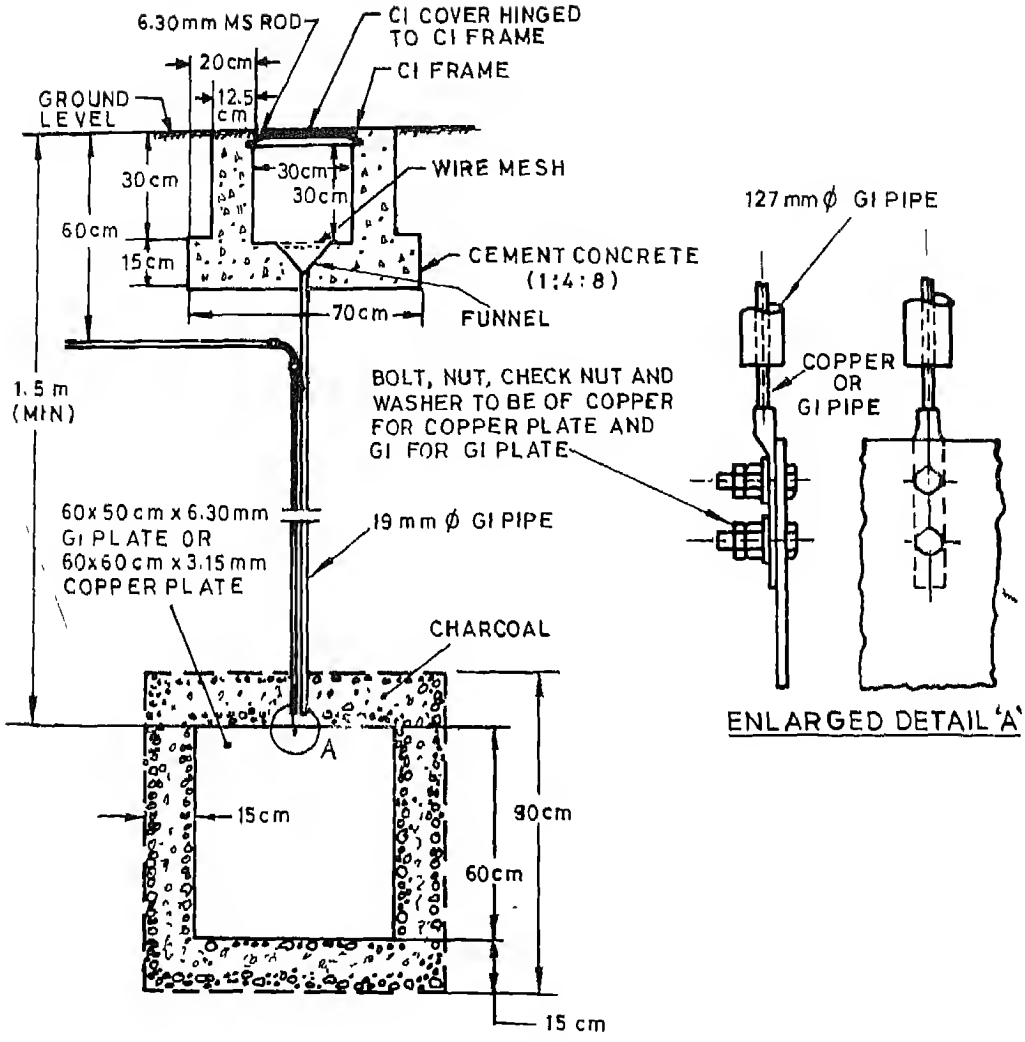


Fig 30 1 Plate earthing

(iv) Copper or GI wire
(v) GI pipe 19mm dia 1.5 mts long
(vi) CI cover hinged with CI frame
(vii) Funnel with wire mesh.
(viii) Cement concrete (1 4 8)
(ix) Earth digging equipments
(x) Charcoal and salt

Procedure

(i) Mark on the ground where earthing is to be done as per requirement
(ii) Dig a pit for earthing plate as the case may be to the required depth
(iii) Put the layer of the charcoal and salt and then place copper plate vertically Again

put charcoal and salt to cover the plate.

Ensure the earthing wire and pipe of funnel and pipe carrying wire are attached properly with plate.

(iv) Put the funnel at the top of funnel pipe with wire mesh.

(v) Concrete the area around the funnel and put CI frame with CI cover on it

(vi) Pour sufficient water through funnel after solidifying concrete for ensuring good earthing

(vii) Connect earth wire taking out through copper plate to the equipment.

Precautions

(i) The earthing electrodes should be situated within 1 5 mts from the building whose installation is being earthed

(ii) The size of continuous earth wires used with cables should not be less than 14 SWG.

(iii) Loose earth or coal salt mixture should be filled around the copper plate for effective earthing

(iv) The size of earth wire run for earthing should be able to carry the full load current of installation offering least resistance to the leakage of current

Questions

(i) Why is earthing essential ?

(ii) What are the equipments and materials required for plate earthing ?

(iii) What is the recommended depth of the earth digged ?

(iv) With specifications of plate earthing draw a neat figure

(v) State the procedure for plate earthing

(vi) What are the advantages of using copper plate rather than aluminium plate ?

To Practise the Measurement of Earth Electrode Resistance

Specific Objectives

(i) To understand the necessity of measurement of earth electrode resistance
(ii) To study the method for measuring earth electrode resistance
(iii) To perform earth resistance test

Related Information

Measurement of earth resistance of an earth electrode is necessary, to save human life from danger or shock, to maintain line voltage constant, to protect large buildings and O.H.lines from lightening If the resistance of earth electrode is more than 1 0 Ohm. the earthing is not said to be proper

A continuous check on earth resistance is necessary and it should never be more than 1 0 Ohms.

In this method two auxiliary earth electrodes of sizes 12 5 mm diameter and 1 25 mts long are placed at a suitable (30 to 50 mts) distance from the earth electrode to be tested Measurement of earth resistance is shown in Fig 31 1 A measured current is passed between electrode 'A' to be tested and an auxiliary current electrode 'C' and then potential difference 'V' between the electrode 'A' and the auxiliary potential electrode 'B' is measured The resistance of the test electrode 'A' is given by $R = \frac{V}{I}$

Where R = Resistance of the test electrode
V = Reading of voltmeter in volts
I – Reading of ammeter in amps

It is important to note that the resistance of earth system shall not be more than 1 0 ohms

Materials

(i) Earth electrode (plate earthing/pipe earthing)
(ii) Two electrodes of 12 5mm. diameter and 1 25 mts. long made of mild steel.
(iii) Hammer
(iv) Earth resistance tester.
(v) Connecting wires of required length

Procedure

(i) Take two electrodes, one as potential electrode and other as current electrode, of sizes 12 5mm diameter and 1 25mts long, made of 12 5mm mild steel rod The earth electrode under test is C.
(ii) Embed the electrode A in earth at a distance 30 mts from the test electrode C The electrode 'B' should be put in between 'A' and 'C' as shown in Fig 31 1 The electrodes should be embedded upto 1mts. in ground
(iii) Connect the electrodes to earth resistance tester as shown in Fig 31 1
(iv) Rotate the handle of earth resistance tester in such a speed that the pointer extends and stops at the point
(v) Record the measurement
(vi) Repeat the test by varying the distance between electrode 'A' and 'C' from 30mts to 50ms Record two more readings

Precautions

(i) There must be sufficient distance between

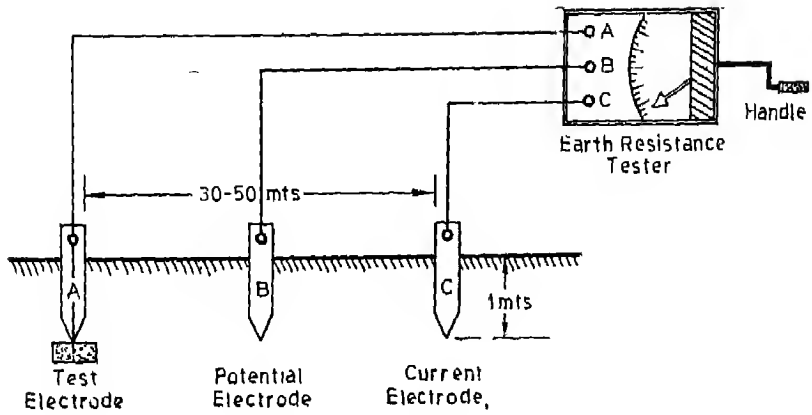


Fig. 31.1 Measurement of earth electrode resistance

electrodes so that their resistance are quite independent

(ii) The resistances of the three electrodes must be of the same order otherwise absurd results may occur

(iii) The handle of earth resistance tester should be rotated continuously till the pointer of the tester stopped.

(iv) Connections should be done correctly and tightly

Questions

(i) Why is it necessary to test the resistance of the earth electrode ?

(ii) How will you calculate the earth resistance ?

(iii) What should be the resistance of a good Electrols ?

Record of Observations

S No	*Distance between Electrodes 'A' & 'C'*	*Earth resistance tester readings in Ohms*
(i)	30m	
(ii)	40m	
(iii)	50m	

To Practise Making Key for Pulley Assembly

Specific Objectives

(i) To develop knowledge in types of files used in an engineering workshop

(ii) To acquire the skills in filing for keys of pulley assembly

Related Information

Filing is used to cut, smooth or fit metal parts, finish a piece to an accuracy for various fittings such as a key of motor pulley.

Filing is an after treatment of chipping It serves to remove burrs from cuts and clean the face of the cuts and to give final finish to the work face By filing, a surface can be finished to the accuracy of 0 15 mm to 0 07 mm A job piece is held in a vice in a level of students elbow The file is moved parallel to the plane of the job piece.

Files are available in various shapes and sizes

Types of Files

Flat File It is rectangular in section and taper slightly towards the point in both width and thickness It has double cut on both sides, and single cut on both edges. It is available in the length of 100, 150, 200, 250, 300 mm or more

Uses

It is used for general purposes filing.

Round File

It is circular in cross section and taper slightly to the point It is available in bastard and second cuts of length 100 to 250mm.
It is used to enlarge the holes of circular openings and to file concave surfaces

Half Round File

It is rounded on one side and flat on other side It is available in bastard, second cut and smooth cut in the length of 100,150,200 and 250 mm
It is used to file concave surfaces and to enlarge half circular openings.

Square File

It is square in cross section available in the length of 100,120,200 and 250 mm in bastard, second and smooth cuts
It is used for general surface filing and key ways in slots

Triangular File

It is triangular in section having double cuts with the corners sharp It is available in bastard cuts in length of 150,200,250 and 300 mm
It is used for filing internal angles, cleaning corners, filing cutting edges

Safe Edge File

It is rectangular in shape having single cut or double cut on both the faces leaving the edge blank The other edge has single cut only, the blank edge protects the adjacent side while filing, so it is called safe edge file It is available in

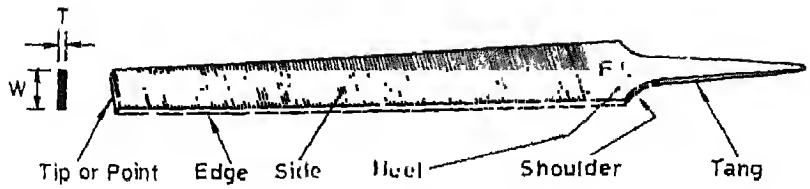


Fig. 32.1 Flat File.

Fig 32.2 Round File

Fig 32 3 Half-Round File.

Fig. 32.4 Square File

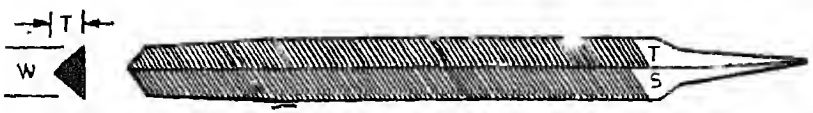


Fig 32 5 Triangular File

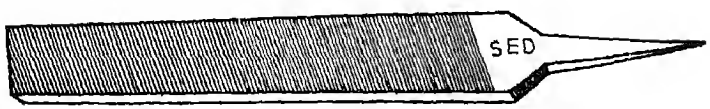


Fig. 32.1 to 32.6 Safe edge file

second cut and smooth in the length of 100, 150, 200 mm
It is used for safe edge filing.

Special Files

These are required for special jobs They are made in different styles, shapes, grade and length

Pillar File

It is similar to square rectangular file but shape is narrow and oblong It has double cut on both faces having edges blank It is available in length of 150,200,250 mm.
It is used for filing slots and key ways.

Warding File

This is rectangular in section having taper towards the point in width and thickness It has double cut in faces and single cut in both edges It is available in length of 100,125,150,200 mm It is used for filing on small slots, notches and in narrow grooves

Mill File

It has parallel width and thickness but one edge or both edges are rounded. It is available in length of 150,200 and 250 mm in bastard cuts, single rounded edges
It is used for filing half round grooves and gulleting mill saw

Rat Tail File

It is similar to round file but the diameter is too narrow like a tail of a rat The taper comes to a lime point It is available in 100, 125 and 150 mm length
It is used for filing, key holes, pin holes, etc

Hack Saw

This is used to cut the metal such as iron rods, strips or pipes etc The saw is available in two forms, the solid frame hack saw and the adjustable hack saw

Hammer

The heads are made of cast steel or forged, the ends are hardened and tampered The striking face is slightly convex Its weight varies from 250 grams to 7 kg The heads of the hammer fitted with wooden handles of different lengths

Cold Chisel

Made of hard steel, the end is hardened and tampered. One end is sharp to chisel off the extra material of iron sheet

Equipment and Materials

(i) Bench vice of 150 mm jaw opening
(ii) Different types of files flats, second cut and smooth
(iii) Try square
(iv) Scriper
(v) Surface plate
(vi) Scale of 300 mm
(vii) Hammer
(viii) Fine clearing brush (Striff steel wire brush)
(ix) A piece of chalk
(x) Mild steel piece.

Procedure

(i) Wet a given M S piece with water and apply chalk on one side of piece
(ii) Place the piece on surface plate and mark the given dimensions with the help of scale, try square, scriber and mark the lines.
(iii) Punch the marked lines at short distances with the help of punch and light stroke of hammer
(iv) Hold the piece in the bench vice in such a way that marked lines are just above the vice jaws

Fig 32 7 Pillar File.

Fig 32 8 Warding File

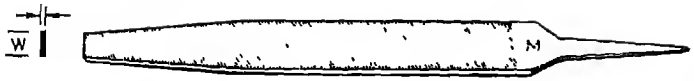


Fig 32 9 Mill File

Fig. 32.10 Rat Tail File

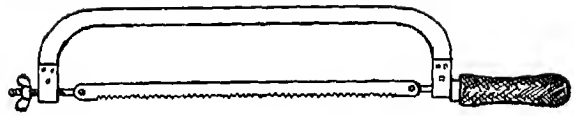
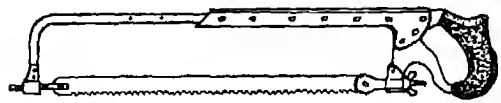


Fig. 32.11 Solid frame Hack saw



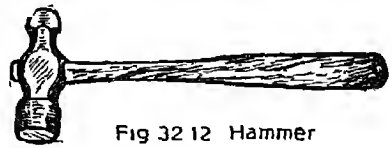


Fig 32 12 Hammer

Fig 32.13 Cold Chisel.

Fig. 32.7 to 32.13 Adjustable frame backsaw

(v) First use the bastard file (rough cut) to remove the extra material in the following manner.

(a) Make sure that the job is in level with the elbow

(b) Place the foot in the direction of the file stroke and right foot at right angle to left foot

(c) Grip the file handle with right hand to guide the file and while working with the file, left thumb should be placed on the end of the file blade and fingers should curl under it for light filing and the palm of left hand for wave filing

(d) Now make the file stroke forward with even pressure

(e) Downward pressure should be released during the return stroke

Now use the smooth file for finishing the job to the required dimensions adopting the same filing procedure as explained above for the bastard file

(f) Use the file parallel to the plane of the job piece

(g) Remove the job from vice and prepare the other side in the same way to the required markings on the M S to prepare a key for a motor

Precautions

(i) Do not use hammer for tightening the job in bench vice.

(ii) Do not rub the hand over the finished surface

(iii) Use soft material between finished surface of work and hardened jaws of vice

(iv) Never use a file without handle and make sure that handle is firmly attached to the file

(v) Do not use clogged file It must be cleaned by cleaning brush before use.

Questions

(i) What are the different types of file ?

(ii) What is the proper way to hold a file ?

(iii) What should be the position of body while filing ?

(iv) Why a file should not be used without a handle ?

(v) Why the hands should not be rubbed over the finished surface ?

(vi) Why the file should be moved parallel to the plane of work ?

Cleaning of Machine Components Using Common Cleaning Agents and Materials

Specific Objectives

(i) To appreciate the advantages and scope of cleaning machine components
(ii) To select proper method of cleaning machine components
(iii) To select proper cleaning agents and materials
(iv) To develop skills for cleaning machine components

Related Information

The productive life of equipment, machines and tools could be extended by scheduling an occasional general overhaul which should include partial as well as complete dismantling. By this process defective parts can be discovered and repaired.

Cleaning by Partial Dismantling

With reasonable frequency an electric motor should be partially dismantled for purpose of cleaning and inspection Inspection of greasing or lubrication effectiveness is essential The lubricant may get oxidised and lubricating holes may get chocked

Partial cleaning by the use of wiping rags and by applying kerosene oil to greasy places with a small painting bush can be effective The connection points and slots may accumulate dust and dirt This is removed by dropping petrol or carbon tetrachloride. Carbon tetrachloride is a better solvent than petrol because petrol is an inflammable cleaning agent and may catch fire due to spark Cleaning of dust and dirt is also done by blowers or by vacuum cleaners Cleaning by vacuum cleaners are always considered better method

Cleaning by complete disassembly

This method alone provides for thorough cleaning of all mechanical/electrical devices

The process of cleaning includes the following methods

(i) *Thermal Methods*
This is used for burning paint material from the body of motor or other painted components. The burning is done by a blow lamp flame

(ii) *Mechanical Method*
Hard brush, emery or aluminium oxide paper/cloth, knifé, etc. is used with which the component is rubbed to remove dirt, oxidised lubricant coating, rust, etc Emery/aluminium oxide papers are abrasive papers available in different grades.

(iii) *Chemical Method*
Special chemical solvent is applied on the surface to be cleaned with brushes. Some such chemicals are lime, chalk, caustic soda The organic solvents used are petrol, carbon-tetra chloride, alcohol, methanol,acetone, kerosene oil, naptha, chloroform.

Small components are cleaned by dipping them into the chemical and then wiping them with a hard brush or rag or chamoy leather depending on the finish of

its surface

(iv) *Cleaning by Emulsified Solutions*
Soap, glycol, ether or petroleum sulphonate, etc are mixed with water to form a non corrosive cleaning emulsions, which are warmed slightly and used for cleaning

Equipment and Materials

(i) Blow lamp
(ii) Hard wire brush
(iii) Hard bristle brush of different sizes
(iv) Soft bristle brush of different sizes
(v) Emery paper/cloth of different grades.
(vi) Aluminium oxide paper/cloth of different grades
(vii) Scraper knife
(viii) Chemicals like lime, chalk, caustic soda, soap
(ix) Other solvents like petrol, C T.C , kerosene, alcohol, acetone, etc.
(x) Wiping rag, chamoy leather
(xi) Blower
(xii) Vacuum cleaner

Procedure

(i) Identify the different types of cleaning materials available in your shop and classify them according to their use in different cleaning methods in tabular form (Table I)

(ii) Take a partially opened motor and clean using appropriate cleaning agents. Record your observations in Table II.

(iii) Take the fully dismantled motor and clean each component using appropriate method and appropriate cleaning agent Record your observations in Table II

(iv) Remove dirt from coils using blower or vacuum cleaner.

Precautions

(i) Do not touch chemicals with your hand

(ii) Drain the oil reservoir of motor bearing and flush it with kerosene oil before using blower or vacuum cleaner

(iii) Do not use solvent or knife for cleaning coils

(iv) Do not keep volatile solvents near fire

(v) When using corrosive chemicals for cleaning a component, wash it well with warm water and kerosene after it is clean

(vi) Clean the components till the defects are totally traceable

Observations

Table I

S No	*Method of cleaning*	*Cleaning agent used*
(i)	Thermal method	(a) Blow lamp (b) Scraper knife (c) (d)
(ii)	Mechanical method	(a) (b) (c) (d)
(iii)	Chemical method	(a) (b) (c) (d)
(iv)	Emulsified solvant	(a) (b) (c) (d)

Table II

S.No.	*Dismantled motor*	*Components cleaned*	*Cleaning agents used*
(i)	Partial	(a) (b) (c) (d) (e)	
(ii)	Complete	(a) (b) (c) (d) (e) (f)	

Questions

(i) What are the different methods used for cleaning of machine components ?

(ii) Describe the mechanical cleaning method

(iii) How will you clean a component which is not approachable by brush or knife and grease and dirt are seen very hardly sticking there ?

(iv) What chemicals are used in chemical cleaning ?

Guided Visit to Electrical Machine Repair Workshop

Specific Objectives

(i) To observe setup of electrical machine repair shop
(ii) To appreciate the house keeping of workshop
(iii) To relate the knowledge of repair work with the process going on there

Related Information

Electrical machine repair workshop is a place where repair and overhauling of different electrical machines is carried out Repair of a machine is associated with dismantling, reconditioning, replacement, rewinding, overhauling, reassembly and testing. To facilitate the working of repair shop different sections of repair workshop are arranged in such a manner that it becomes time saving, least moving and easily supervisable. To move heavy parts of machine suitable crane is provided in the repair shop To keep different parts, tools, equipment and instruments in scientific manner at their proper place is called house keeping of the workshop and for safe working it is an essential activity

While visiting an electrical repair workshop one should carefully observe the different sections of the repair shop and tools, equipment, instruments and machines therein and also the process of the work going on there He should also observe the house keeping rules of the workshop, the poster and caution affixed for the purpose

Before going for visit to an electrical repair shop one must have the theoretical knowledge of tools, equipment, instruments and machines required, for an electric repair shop and their use and also the knowledge of its layout It helps in better understanding of the working, safety and industrial setup

Materials Required

(i) Note book
(ii) Pen

Procedure

(i) Observe and note different sections of the repair shop
(ii) Observe and note equipment, tools, and machines of different sections
(iii) Observe the process of work going on in each section.
(iv) Observe the house keeping rules in the workshop.
(v) Observe for material handling process, machine, equipment in the workshop.
(vi) Prepare a visit report mentioning above facts after the visit

Precautions

(i) Visitor must be in proper dress
(ii) The instructions of the guide must be followed
(iii) The working of workshop should not be disturbed
(iv) Visitor must not operate any machine, equipment or instrument
(v) Visitor should move carefully in the work-

shop keeping him away from line and moving parts

Observations

S No	*Sections Observed*	*Machines Observed*	*Tools and Equipments Observed*	*Material Handling Observed*	*Housekeeping Observed*	*Process Observed*
(i)						
(ii)						
(iii)						
(iv)						
(v)						

Questions

(i) What is the importance of layout of a workshop ?

(ii) Why is house keeping essential in a workshop ?

(iii) How does the theoretical knowledge help to make the visit more useful ?

(iv) Name different sections and their purpose in the repair shop you visited

(v) What arrangements are provided for rewinding of a motor in the repair workshop you visited ?